MARCH 1926—THIRTY-SECOND YEAR

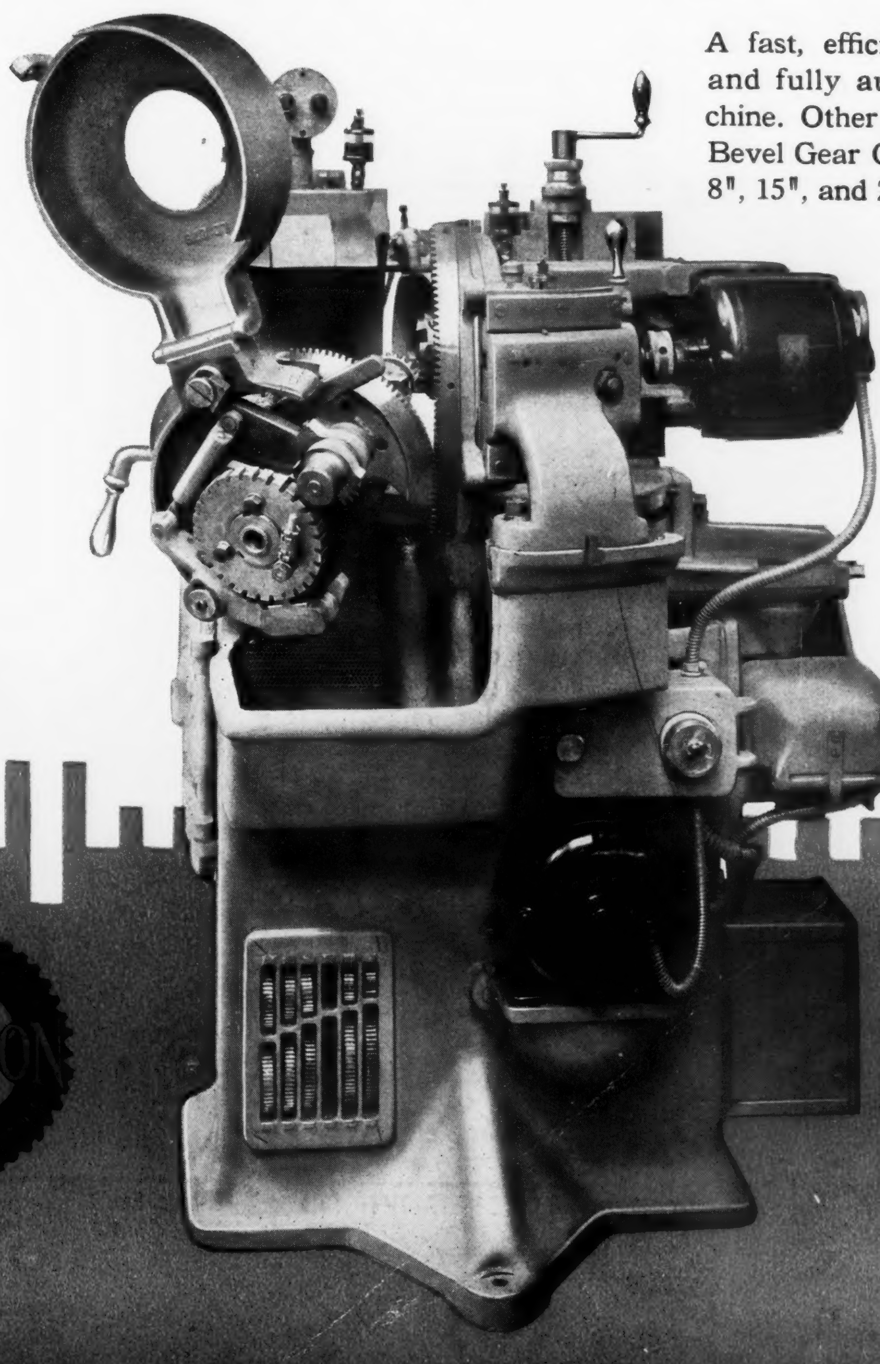
MACHINERY

THE INDUSTRIAL PRESS Publishers, 140-148 LAFAYETTE ST., NEW YORK

Gleason
Spiral Bevel Gear Machinery

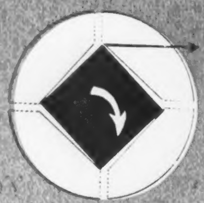
Spiral Bevel Gears from the smallest sizes up to 4 inch diameter, 8 Diametral Pitch can be cut on the 4 inch Spiral Bevel Gear Generator.

A fast, efficient, accurate and fully automatic machine. Other sizes of Spiral Bevel Gear Generators are 8", 15", and 25".

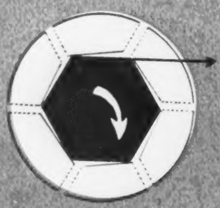


Descriptive Leaflet will be sent upon request

GLEASON WORKS
Rochester, N.Y.

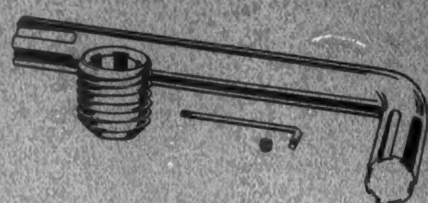


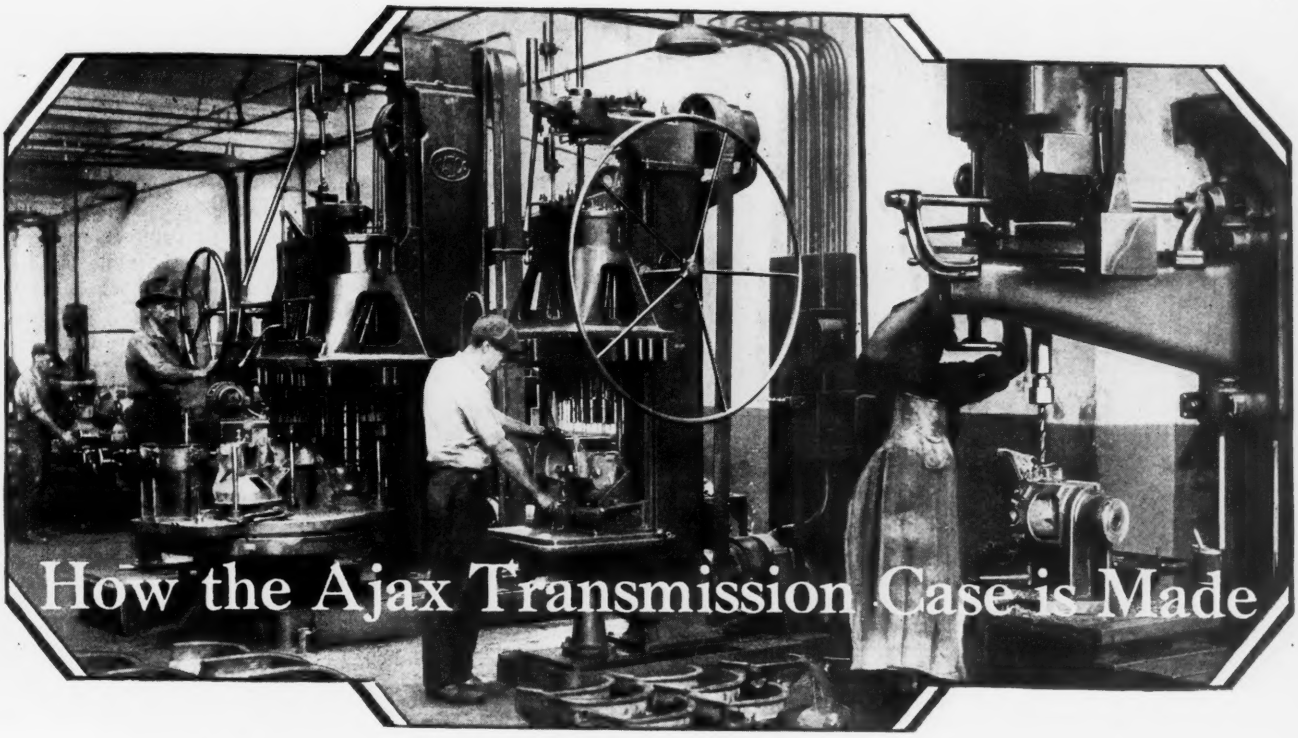
Tendency to Pry Walls Apart



Note Direction Power is Transmitted

Pulls Screw Around No Expanding Pressure





How the Ajax Transmission Case is Made

Production Methods Used in an Automobile Plant Recently Equipped Throughout with New Machines and Tools

By CHARLES O. HERB

BECAUSE of the fact that the automobile industry is the greatest user of machine tools, and because the question of production costs is possibly of greater importance in this industry than in any other, all other users of machine tools find it well worth while to study the machine equipment that the plants in this field select and install. It is logical to assume that the best methods should be found in the new automobile plants, because they are not hampered by having to try to put existing equipment to its best use, which generally means a compromise; but when new plants are equipped, the machines, jigs, fixtures, and tools are usually decided upon in accordance with the best known practice, the decision being based upon the experience of automobile production engineers in cooperation with machine tool builders.

As an example of a newly equipped plant where the best available experience of both automobile engineers and machine tool builders seems to have been taken into account, may be mentioned the Ajax Motors Co., Racine, Wis., where a number of the machine line-ups present interesting examples of high efficiency in production. It is difficult to determine which one of these holds the most interest for MACHINERY's readers, but certainly the transmission case line is as interesting as any of the others, and this article, therefore, will describe the more important operations performed on the transmission case, the present production of which averages 125 cases per ten-hour day.

Milling Operation in which Four Cutters are Used

The first operation on the transmission case, after filing and chipping, consists of milling surface *a* of the rear end, Fig. 3, the top surface *b*, and surface *c* of the bell housing.

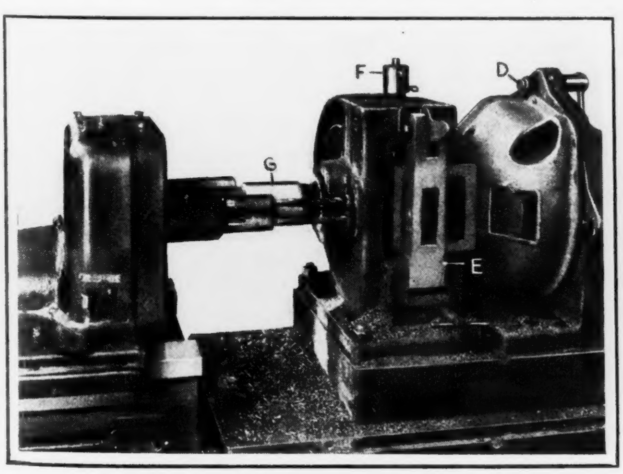


Fig. 1. Close-up View of the Jig and Left-hand Tool-head on a Duplex Type of Machine used for boring and drilling the Transmission Case from Both Ends

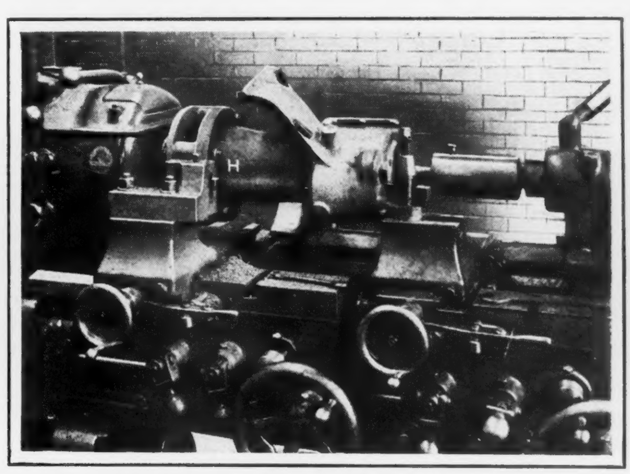


Fig. 2. Set-up employed in an Engine Lathe for accurately facing the Bell Housing Flange and Rear End in Relation to the Main-shaft Bearings

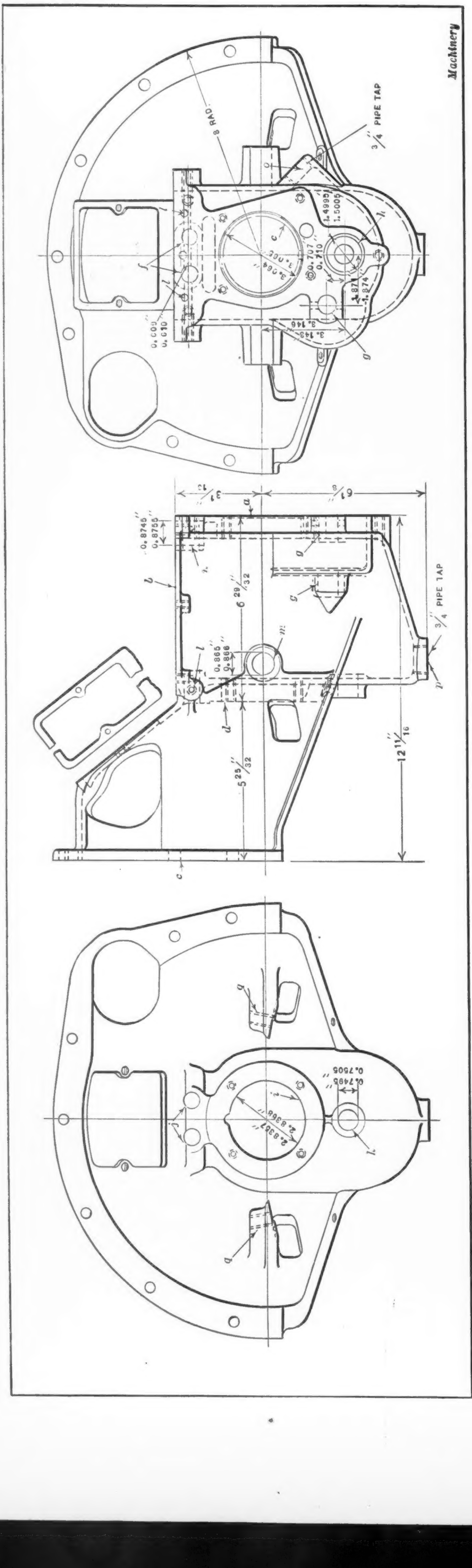


Fig. 3. Detail Views of the Transmission Case with which **Ajax Automobiles** are equipped

This operation is performed in an Ingersoll milling machine equipped as illustrated in Fig. 4, from which it will be seen that the rear end is milled by an 8-inch cutter *A* on a horizontal shaft, the top surface by another 8-inch cutter *B* on a vertical shaft, and the bell housing flange by two 4-inch cutters *C*. The two small cutters are mounted near the periphery of a large revolving drum which carries them at the proper radius for rough- and finish-milling the irregular bell housing flange as they revolve on their own axes and that of the drum.

As the drum starts revolving, a large slide on which the other two cutters are mounted, moves toward the front of the machine feeding the cutters across the work. When the forward travel of the slide is completed, a reverse feed is automatically engaged to return the slide to the rear of the machine. The drum continues revolving to a certain point where the drive to this unit is tripped. Then both the drum and slide remain idle until the operator reloads the work and moves the starting lever.

For this operation, the transmission case is held firmly in a sturdy fixture provided with a heavy hinged member *M* which is swung over the bell housing. Various clamps and stops prevent the transmission case from shifting or vibrating under the pressure of the cuts. The fixture is bolted stationary to the bed of the machine. About 1/8 to 5/32 inch of stock is removed from each of the three surfaces in this operation.

Drilling, Boring, and Reaming in Two-way Machines

After two dowel-holes have been drilled through the bell housing flange and the front end *d*, Fig. 3, of the case proper has been rough-milled in a vertical milling machine, the case reaches two Rockford double-end boring machines. The first of these machines is used for drilling and boring various holes, and the second machine finish-bores and reams the same holes. Fig. 1 shows a close-up view of the jig and left-hand toolhead of the first machine with the work in place. This head is employed to rough-bore the rear main-shaft bearing *e*, Fig. 3, drill the two shift-rail holes *f*, and drill the rear countershaft bearing *h* to a diameter of 1 7/16 inches. Tools in the right-hand head are used to bore the front main-shaft bearing *i*, two holes *j* for the shift rails and the front countershaft bearing *k* to a diameter of 11/16 inch. The movements of both heads are controlled through a push-button located on the front of the machine.

The fixture is made in two sections, one of which supports the transmission case proper and the other the bell housing. The transmission case seats against stops on the bottom and at the back, and is located accurately by means of dowels which enter the two holes previously drilled in the flange of the bell housing. Clamp *D*, Fig. 1, is moved longitudinally by turning a handle, to draw the bell housing flange firmly against the right-hand fixture. A similar clamp is pulled against the lower edge of the bell housing flange by operating a handwheel on the front of the fixture, which cannot be seen in the illustration. Hinge *E* is then swung upward and locked to the top of the left-hand fixture, this hinge being equipped with a two-point equalizing member which bears on surface *b*, Fig. 3. Screw *F*, Fig. 1, is revolved to clamp the transmission case on the side that is uppermost. Each boring-bar for the main shaft bearings is firmly supported by a sleeve *G* which enters a slip bushing in the fixture, and slip bushings are also provided for each of the drills.

The second machine of this type is equipped with a similar work-holding fixture, and is used for finish-boring and reaming the main-shaft bearings *e* and *i*, Fig. 3, and for reaming all other holes drilled in the first machine. After the transmission case is removed

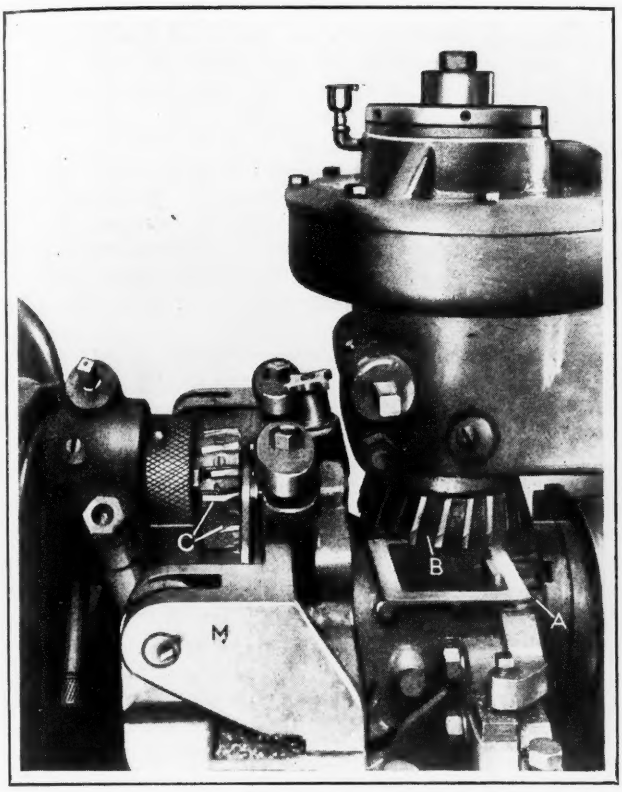


Fig. 4. Machining Three Surfaces of the Transmission Case by the use of Four Milling Cutters

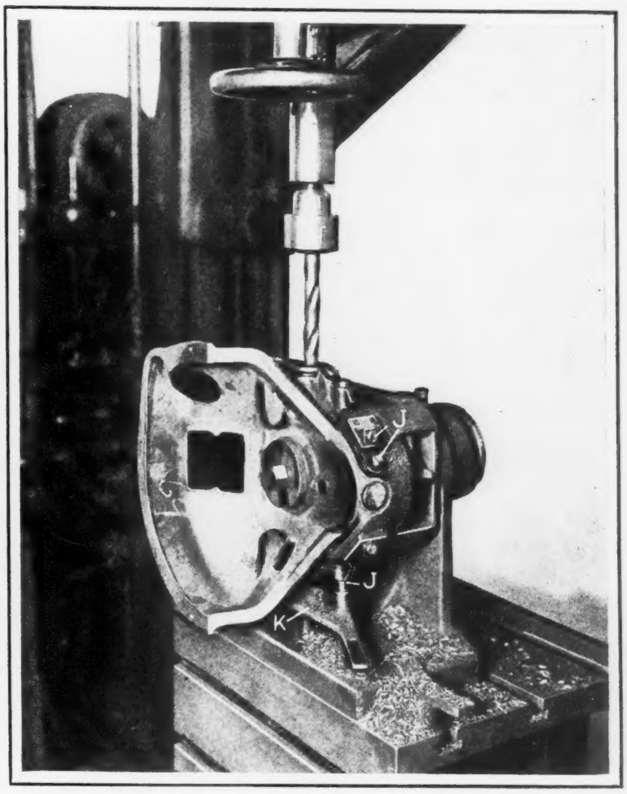


Fig. 5. Rotary Jig used in Connection with Various Tools which are changed Twelve Times for machining Holes in the Case

from the second machine, it is placed on a bench for line-reaming the main-shaft bearings.

Facing Both Ends of the Transmission Case

The transmission case is then placed in the engine lathe illustrated in Fig. 2, and surfaces *a* and *c*, Fig. 3, are faced accurately at right angles to the main-shaft bearings. Accuracy of this operation is insured by supporting the work at the two main-shaft bearings by means of a rotating arbor, the shank of which is inserted in a large socket attached to the tailstock spindle. The front end of the arbor is fastened to chuck *H*, Fig. 2, so that the arbor is driven by the chuck. A plug on the chuck enters hole *k*, Fig. 3, in the transmission case for driving it, and surface *d* of the case is positively located by three plugs on the front end of the chuck.

It will be noticed that this engine lathe is equipped with two separate carriages, one of which is equipped with a special toolpost and a tool that is fed crosswise for facing the bell housing flange. The other carriage is provided with a tool that is also fed crosswise for facing the opposite end of the case. In unloading a transmission case, the tailstock and auxiliary socket are pulled back together, leaving the arbor attached to the chuck. The case is then slipped off the arbor without disturbing the latter. After a new transmission case has been loaded, the tailstock is again advanced to support the projecting end of the arbor during the operation.

Drilling and Tapping the Ends of the Case

Next, surface *d*, Fig. 3, of the transmission case is finish-faced and the front countershaft boss is spot-faced. For these cuts, a combination tool is employed, and a stop-collar is provided on the spindle to control the depth of the cuts. Another drilling machine, equipped with a pivoting fixture, is used to drill and ream the reverse idler-shaft bearings *g*, spot-face the inside surface of the wall adjacent to the front countershaft bearing, and chamfer bore *e* on the outside edge to an angle of 45 degrees and a depth of 1/64 inch. Then a horizontal type of drilling machine is used to face the two

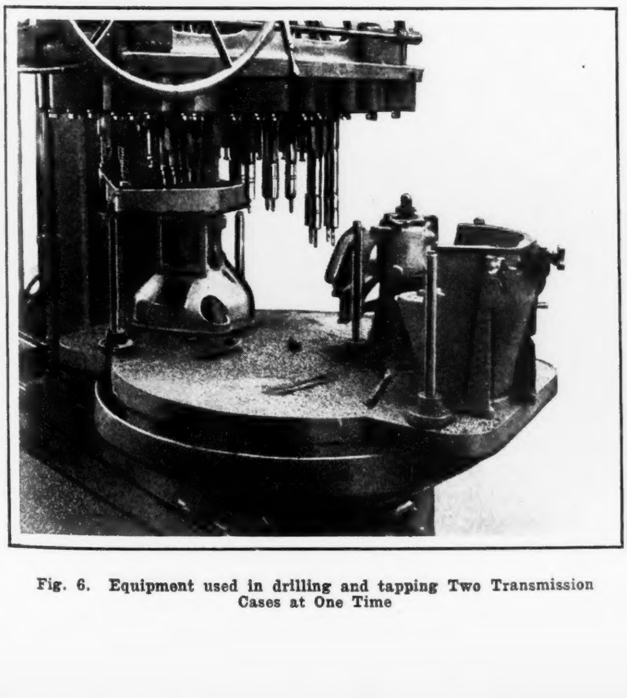


Fig. 6. Equipment used in drilling and tapping Two Transmission Cases at One Time

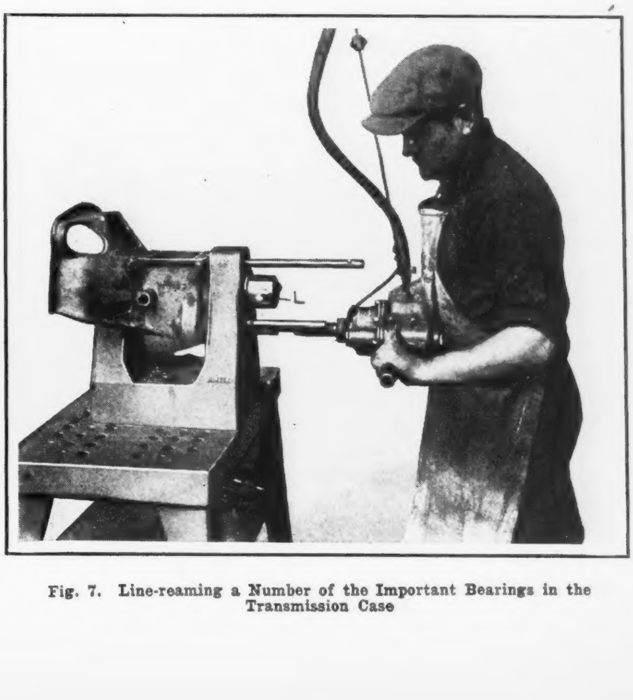


Fig. 7. Line-reaming a Number of the Important Bearings in the Transmission Case

adjacent inside bosses of the reverse idler-shaft bearings *g*, after which a special duplex drilling machine is employed for drilling and reaming the interlocking holes *l*.

The multiple-spindle drilling machine illustrated in Fig. 6 is next used for drilling nine holes and tapping seven of them in the rear end of one transmission case, and for simultaneously drilling nine holes and tapping four of these, in the front end of a second case. By operating on two castings at one time, one transmission case is turned out for every two down feeds of the drill head, the first down feed being required for drilling the eighteen holes and the second for tapping the eleven holes. Five of the holes in the front end are in the bell housing flange and the other four are drilled in surface *d*. It will be remembered that two holes in the bell housing flange were drilled and reamed in the third operation to serve as locating points in several of the operations already described.

On the table of this machine there are two sets of two fixtures each, so that the work can be loaded on one set of fixtures while the operation is being performed on two cases loaded on the opposite side of the table. The work is accurately located on each fixture by means of an upright arbor on which the main-shaft bearings of the transmission case are seated. The fixture used in drilling the bell housing end is provided with three spring plungers, which support the under side of the flanges and are locked in place after the transmission case has been seated on the fixture.

The illustration shows the drilling step in progress; when this step has been completed, a spring plunger is withdrawn from the table by means of a lever beneath the table, and the foot-treadle is depressed to index the same two pieces of work under the tapping spindles. These spindles are grouped on the right-hand side of the drill head, as may be readily seen. When the tapping has been completed, the table is indexed to bring the finished cases to the front of the machine and the newly loaded ones beneath the drill spindles. In the drilling operation, a drill bushing holder attached to the drill head is supported on the plugs of three posts on the fixture and on a fourth plug in a boss on the fixture.

Another multiple-spindle drilling machine located immediately to the right of the one just used, as may be seen in the heading illustration, is next employed for drilling and tapping nine 5/16-inch holes in the top of the transmission case. For this operation, the work is held in a fixture that can be slid from right to left and vice versa beneath two groups of spindles. Three radial drilling machines are then used in succession for drilling and tapping two 1/4-inch holes for the screws of the hand-hole cover; drilling and tapping two 1/4-inch holes in the ribs that extend from the lower portion of the transmission case proper to the flange of the bell housing; drilling, spot-facing, and tapping a hole *q*, Fig. 3, for the clutch-operating lever on only one side of the case, and drilling a small hole through one reverse idler-shaft boss. In each of these machines, the work is mounted in a suitable fixture.

Jig of Unusual Design

Fig. 5 illustrates an operation in which a simple rotary jig mounted on the table of a radial drilling machine is used in connection with various tools which are interchanged twelve times for each transmission case. As the jig is exceptionally quick-acting and the tools are substituted with ease, the operator can readily keep up with the production of the other machines. The jig consists essentially of a combined base and upright, which contains a generous bearing for a second revolving member. This revolving member is provided with a horizontal arbor on which the main-shaft bearings of the transmission case are seated for accurate location. By the use of this jig, holes are conveniently machined not only in the top, back, and sides of the transmission case, but also in a slanting surface that requires the work to be held in an angular position.

The various positions are easily obtained by means of a series of threaded plugs *J*, which are located around the rotary member. For each position of the jig, two of these plugs rest on two similar plugs held vertically in handle *K*. With this arrangement, the jig cannot revolve when the handle is in place as shown in the illustration, and for each indexing, the handle is simply swung forward, the jig revolved by hand the necessary amount, after which the handle is swung back again into place.

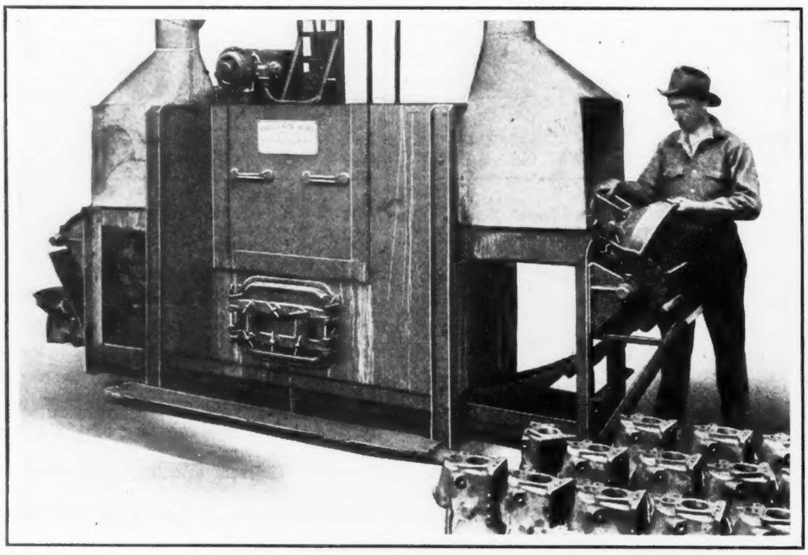


Fig. 8. Operator removing Transmission Cases from the Washing Machine in which they are thoroughly cleansed from All Oil and Chips

The first step consists of drilling the control shaft hole *m*, Fig. 3, on the right-hand side of the transmission case, looking at the case from the front end, after which a reamer is inserted in the machine spindle for reaming this hole. The reamer is then changed for a 7/16-inch tap, which is used for tapping the right-hand hole *l* to a depth of 1 inch. When the jig has been indexed 90 degrees, hole *n* on the top is drilled and reamed successively. Then the jig is indexed 45 degrees for drilling and tapping filler hole *o* (3/4-inch pipe tap). The jig is next indexed another 45 degrees to bring the left-hand side of the transmission case uppermost, so as to drill and ream hole *m* on this side of the case and tap the left-hand hole *l*. Finally the jig is indexed another 90 degrees to bring the bottom uppermost for drilling and tapping the drain hole *p* (3/4-inch pipe tap). Slip bushings are used in the cases where the holes drilled are also to be tapped, and in the tapping steps the rotation of the machine spindle is reversed to withdraw the tap, and the rate of feed is changed.

Line-reaming Several Holes

At the end of the preceding operation a small half-hole is drilled on the upper side of the front main-shaft bearing in a vertical drilling machine of standard design, after which the transmission case is placed in the fixture illustrated in Fig. 7. This fixture is employed for line-reaming accurately, in relation to the main-shaft bores, the shift-rail holes *f* and *j*, Fig. 3, the countershaft holes *h* and *k*, and the idler-shaft holes *g*. When the transmission case has been placed in the fixture, the large-diameter arbor *L*, Fig. 7, is entered through two bearings in the fixture and the two main-shaft bearings of the transmission case. This arbor serves to seat the case accurately for the operation, stops being provided on the fixture for locating the case radially. In reaming the different holes, the line-reamers are started by hand and then an air drill is used to drive them through their respective bearings. A socket on the drill is slipped over the shank of the reamers

in such a way that a pin, extending through the shank, enters slots in the drill socket to furnish a means of driving.

Four dowel-holes are next reamed in the bell housing flange on a sensitive radial drilling machine, and then any necessary filing or chipping is done. The transmission case next reaches the washing machine illustrated in Fig. 8 through which it is carried by means of a conveyor, and thoroughly cleaned from all oil and chips. The generous use of metal washing machines throughout the motor shop constitutes an important feature of the Ajax plant. These machines are located at the ends of the different machine line-ups for washing such parts as the cylinder, cylinder head, transmission case, etc., just before the parts reach the inspection benches. From the inspection benches the parts are immediately assembled into motors, the different machine line-ups being arranged at right angles to the assembly conveyor, so that the parts are delivered to the conveyor at the points where they are required by the assemblers.

* * *

EARLY HISTORY OF FILES

Some information on the early history of files has been collected by Henry Disston & Sons, Philadelphia, Pa. Specific references to files were made by Daimachus, a Greek writer in the time of Alexander the Great, about 300 years B. C. This writer enumerates four kinds of steel, describing their uses. From one kind were made files, augers, chisels, and implements for cutting stone. There is evidence, however, that files were used at a much earlier time than this. Several specimens of ancient bronze files are still in existence. One of these, believed to be about 3500 years old, was dug up in Crete by an expedition from the University of Pennsylvania. This file is now in the museum at Candia, Crete. It has a rounded back, as well as a flat surface, bearing an astonishing resemblance to the half-round file of today. It is about 3 5/8 inches long, 3/8 inch wide, and 1/4 inch thick. One of the earliest examples of iron files was found on the site of the Swiss lake dwellings, and dates from the time when Europe was the home of a race far more ancient than any of which we have any permanent records. This file has coarse teeth running across the blade at right angles to the sides and has a well developed tang, much like that of modern files. Another ancient iron file forms part of the collection of tools left at Thebes in Egypt by Assyrian invaders. This file is believed to date from about the seventh century B. C. Files have been found on the sites of the old Roman camps in England.

* * *

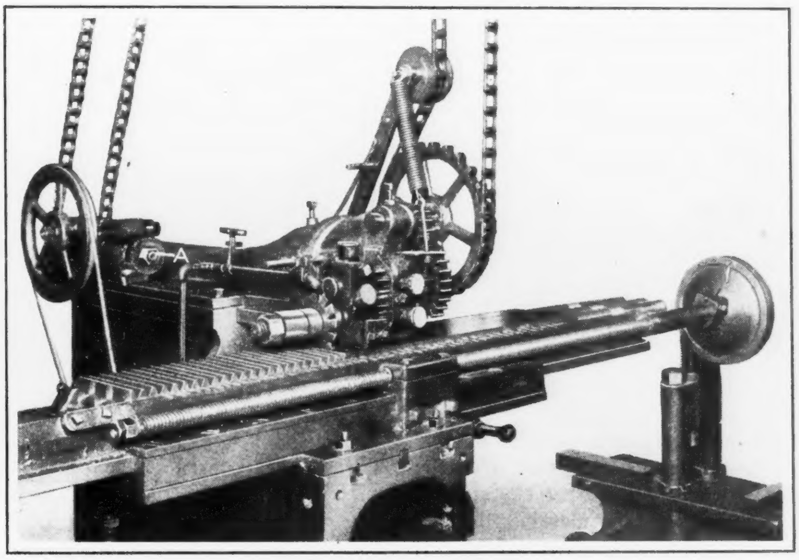
A novel form of road vehicle has recently been completed which is believed to have a promising future. This is a double-truck, eight-wheel passenger-carrying bus resembling a large street car. The use of eight wheels gives greater capacity than has hitherto been obtainable with buses of four or six wheels, and greatly improves the riding characteristics. The power is generated by a large six-cylinder Waukesha engine, direct-connected to a Westinghouse generator. Two motors are used for propulsion, one being mounted on each truck.

RACK-CUTTING ATTACHMENT FOR SHAPER

By ARTHUR L. GREENE

An unusual adaptation of the ordinary shaper to rack-cutting purposes, as shown in the accompanying illustration, was made in the plant of the E. & B. Holmes Machinery Co., Buffalo, N. Y., manufacturer of cooperage machinery. The attachment can be applied to any shaper of standard make, and should be of use wherever the amount of work handled does not warrant the purchase of a regular rack-cutting machine. It was designed especially for milling racks made of 0.40 per cent carbon steel having a 10-inch face and a pitch of 2 inches, but can be used for milling racks of any desired pitch or width within its capacity.

As shown in the illustration, the attachment has a chuck for holding the rack and a graduated screw with an indexing device for determining the exact pitch desired. A feed-screw attachment, which operates through a split nut, provides the forward feed to the ram and at the same time allows the ram to be returned quickly at the end of the stroke. The milling attachment itself is bolted directly to the head of the shaper ram with the bolts used for holding the tool-block.



Shaper equipped with Rack-cutting Attachment

The chuck is 6 feet in length, and the rack to be milled is held in position by a pair of ordinary clamp jaws. The block supporting the chuck is stationary and so arranged that it holds the rack directly under the cutter tools, thereby insuring ample rigidity of the work during the machining operation. The screw *A*, which serves to feed the milling cutter across the work, is driven by a worm-gear, as shown, which, in turn, is connected by a chain drive to an overhead countershaft. It is unnecessary to remove the feed-screw when the machine is used as a shaper, as it can be released by simply opening the split nut on the end of the shaper ram.

The body of the milling attachment secured to the ram is made of a solid iron casting with split bearings for holding the cutter-arbor and its auxiliary driving shaft. Spur gearing is used to drive the cutter-arbor, the teeth in the latter member being cut from the solid metal, while the driving shaft is provided with a keyed-on gear. The latter gear is, in turn, driven by a pinion and sprocket gear as indicated. In milling medium sized racks, the roughing and finishing cuts are taken simultaneously by equipping the arbor with two cutters. For the smaller racks, having a pitch of 1/2 inch or less, a gang of cutters that mill three grooves simultaneously is used.

* * *

Brass was produced in the American Colonies for the first time at the iron foundry of John Winthrop, Jr., in Lynn, Mass., in 1644. A brass industry, however, did not develop until over a century later. About 1750, John Allen established a brass factory in Waterbury, Conn., the brass being used chiefly in the manufacture of buttons. From this humble start the brass industry of the United States, transplanted almost bodily from England, has grown to be the greatest brass industry in the world. The state of Connecticut alone now produces 60 per cent of the world's brass.

DIES FOR FORMING TUBES FROM FLAT PLATES

By F. H. SERVER

The combining of piercing and forming operations in the production of tubular work often presents some interesting problems, especially where accuracy is required. The accompanying illustrations show a set of dies used for making a

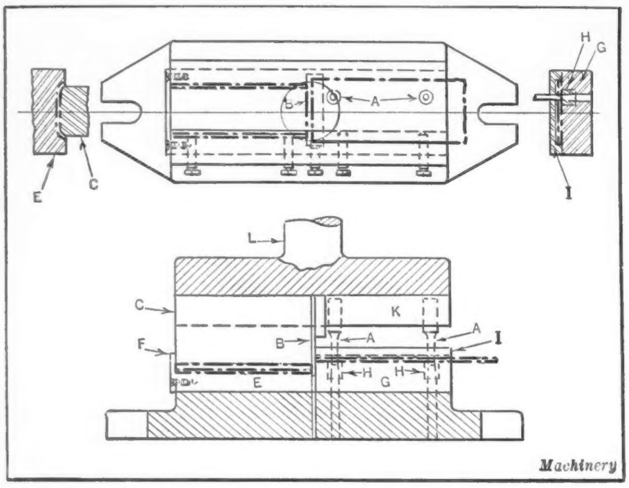


Fig. 1. Die for Piercing, Cutting off, and Bending Operations

piece in which part of the piercing is done in the flat stock before it is formed, and duplicates of these pierced holes are produced in the other half or side of the tube after it is formed in order to bring both sets of holes into alignment.

In Fig. 1 the work is indicated by heavy dot-and-dash lines. The strip stock is fed from right to left. Two punches *A* pierce holes through the strip of stock, after which it is fed forward a distance equal to the length of one piece. As the ram of the press again descends, the wide punch *B* cuts off the end of the strip, following which the long forming punch *C* turns up the edges of the work which is to form the tube shown by the dot-and-dash lines at *N*, Fig. 2. The forming punch *C*, Fig. 1, operates in conjunction with the die *E*, and the end of the stock is fed against the stop *F*, which determines the length cut off. The piercing die consists of a block *G* in which two die bushings *H* are placed, together with a combination stripper and guide plate *I* through which the stock passes.

The forming portion *E* of the die and the cutting-off and piercing unit *G* are secured to a cast-iron holder by screws, and the piercing punches *A* are held in the block *K*. Block *K*, forming punch *C*, and cutting-off punch *B* are held to the upper member *L*, which is secured to the ram of the press. After the work has been pierced and the edges formed, it is placed in a forming die of the type shown at the left in Fig. 2.

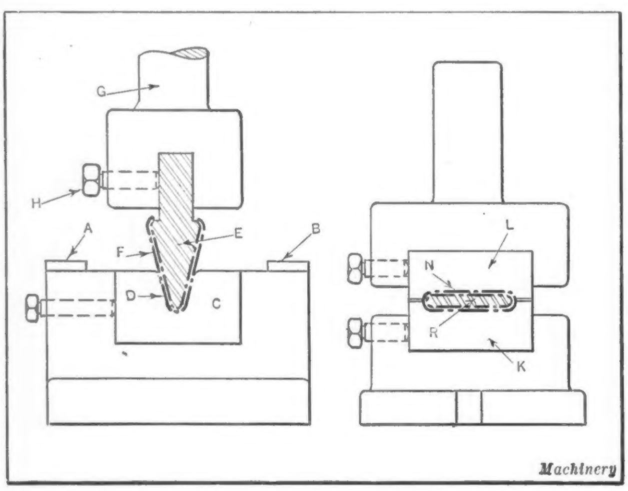


Fig. 2. Bending and Forming Dies for Flat Tubular Piece

The work is placed across the top of this die between the plates *A* and *B*, which locate it over the forming die. When the forming punch *E* descends, it forces the blank into the groove *D* cut in the die *C*. This operation forms the work to the shape shown by the dot-and-dash lines. Punch *E* is clamped in the slot in holder *G* by screws *H*. The hooked ends of the work cling to the punch, so it must be slid off endwise.

The next operation is performed on the die shown at the right in Fig. 2. The upper die *L* and the lower die *K* are similar, and give the work its finished shape when formed over the arbor *R*, which is placed inside the work after it has been removed from punch *E* of the forming die shown in the view at the left.

The die shown in Fig. 3 is employed to punch two holes in the blank side of the formed piece. These holes must align with the previously pierced ones on the opposite side of the tube. Only one hole is punched at a time, the hole

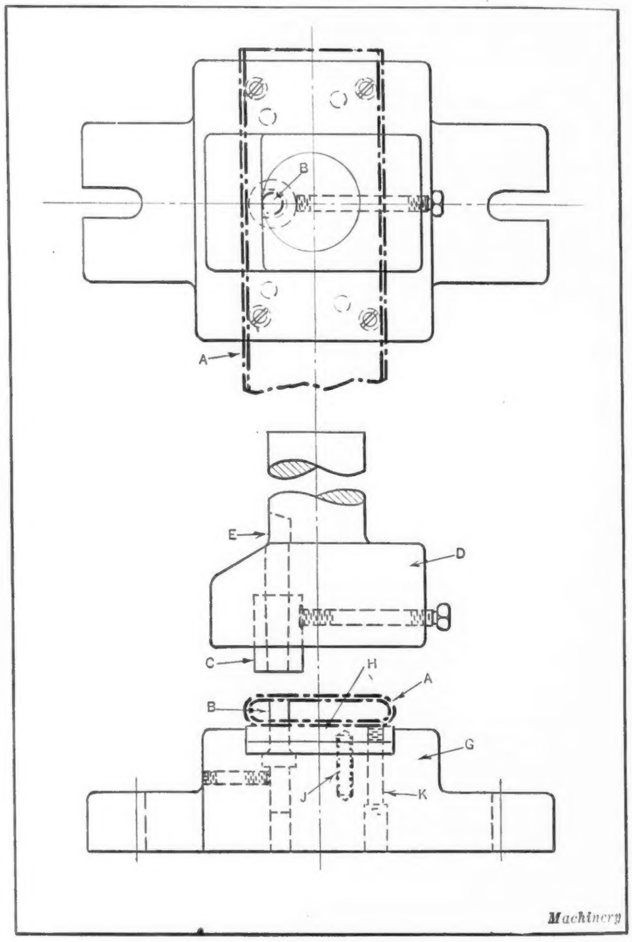


Fig. 3. Die for Final Piercing Operation

on the opposite side being used to locate the work. Referring to the lower view, one of the pierced holes in the tube *A*, shown by dot-and-dash lines, is located over the punch *B*. When the ram of the press descends, punch *B* pierces the hole in the upper side of the work, forcing the slug up into the die clamped in the holder *D*. The hole at the other end of the work is pierced in the same manner. The slugs punched from the work pass upward through the die bushing *C* and out through the hole *E* cut in the holder *D*. The holder *G* is provided with a plate *H* which is free to slide up and down. Plate *H* is forced upward by a series of springs *J*. The four screws *K*, however, limit the upward travel of plate *H*, which acts as a stripper to force the formed tube *A* from punch *B*.

* * *

Eighteen Diesel engines have been ordered by the U. S. Shipping Board to be used for converting existing steamships into motorships. These engines range from 2700 to 3000 brake horsepower.

Notes and Comment on Engineering Topics

One of the latest devices for facilitating traffic is a moving sidewalk similar to an escalator, which has been tested out in Bellevue, a suburb of Paris, according to *Safety Engineering*. The results of the tests were so satisfactory that it has been decided to install this conveyance on one of the principal thoroughfares of the city, with the idea of determining its value under urban traffic conditions. The moving sidewalk carries traffic both ways, and beside each of the moving walks there is a stationary board walk for those who prefer to trust to their own motive power.

A novel experiment is being tried in Baltimore where three-wheeled taxicabs built by the Indian Motorcycle Co., of Springfield, Mass., have been placed in operation. These taxicabs are built to carry two passengers besides the driver, and are built like a motorcycle with the side car enclosed. The enclosed body is of the regular sedan type fitted with dome-light, sliding windows, and the ordinary conveniences found in taxicabs. The weight of these vehicles is slightly less than 900 pounds. The automobile industry will watch the results obtained with these taxicabs with a great deal of interest.

The completion of a new $75,000 two-story and basement commercial building for the Peerless Auto Sales Co. in the heart of the business section of Canton, Ohio, marks the definite acceptance by structural engineers of the electric arc welding process for joining members in the fabrication and erection of steel structures of types for which this method is suitable. This structure is entirely electric welded, both in shop fabrication and erection. Not a single rivet has been used to join any of the various members which make up the steel framework of this 100- by 150-foot building. The work has been done by the Morgan Engineering Co., of Alliance, Ohio, using Lincoln Electric Co. arc welding machines. The labor cost in the fabrication of the structural steel alone was reduced 23 per cent below the cost estimated for a riveted construction.

An interesting application of the gas-electric drive is being made by the Pennsylvania Railroad Co. in the operation of a vertical-lift bridge across the Chesapeake and Delaware Canal, which is being installed south of Philadelphia. As the bridge is remote from electric power lines, the gas-electric drive was decided upon as being the cheapest method of operation, the complete electrical equipment having been furnished by the General Electric Co. Two sets of 100-kilowatt gas-engine-driven generators and exciters are installed in the operator's house on the shore, together with a switchboard and the necessary control devices. Two 100-horsepower motors, operating the bridge, are located in the machinery house on the bridge itself, connected with the shore by flexible cables. Each of the motors is sufficient to operate the bridge alone, one of the generating sets being held in reserve.

The amount of deflection of a brick wall 40 inches thick under the pressure of one finger can be measured by an instrument recently constructed by C. G. Peters of the Bureau of Standards, Department of Commerce. If one looks into the eyepiece while some one else walks across the floor the deflection is apparently so great that one would suppose the whole building to be swaying back and forth as though made of cardboard. The instrument makes use of the interference of light waves, and is very simple in construction. A glass plate is fastened to the wall of the building. Another plate is mounted close to this first plate in the tube of the instrument. Part of the light from a helium tube passes through the plate in the instrument and is reflected back by the plate on the wall into the eye-piece. The remainder is reflected directly from the plate in the instrument. The interference of these two sets of light rays causes light and dark bands to appear in the field of the eye-piece. When the distance between the two plates is changed, the bands move across the field. Motion equal to the distance between two dark bands represents a deflection of about 0.00001 inch.

Coal has been and will continue to be the chief fuel used in the production of steam, says *Mechanical Engineering*, but the greatly increased cost of coal has made necessary a careful study of the most efficient means of burning it. Pulverized coal, long used in the cement industry, is being adopted more and more for modern steam stations. During the past year at least six large plants using this fuel have been put into service, and more are under construction. Much study is being given to the improvement in equipment for the preparation of the coal. Mills have been increased in capacity with a decrease in power consumption per ton of coal pulverized. The old rotary drier has given way to the waste-heat or flue-gas drier, and this is losing ground to the steam drier using steam bled from the main generating units. Rapid strides are being made in the development of burners and in the design of furnaces. Burners are being developed in which the air and coal are mixed in proper proportions before introduction into the furnace, with consequent shortening in length of flame and decrease in the size of furnace volume required for proper combustion. The so-called "unit system" of preparation and burning is being used more and more in the smaller stations; for the large stations, the separate preparation plant is universally used.

In a report on progress in materials handling, presented by the Materials Handling Division of the American Society of Mechanical Engineers before the recent annual meeting of the society, it was pointed out that a study of the handling operations involved in the production of iron castings in the foundry, conducted by Max Sklovsky, chief engineer of Deere & Co., Moline, Ill., indicated that, on the average, for each ton of finished castings produced, 168 tons of materials of one sort or another were required to be handled. Extending the survey to cover the handling operations involved in the production and transportation of the basic materials employed in making the castings, their subsequent machining and assembly with other materials into one of the products of the metal trades, such as an automobile or agricultural implement, according to conventional manufacturing methods, it is estimated that a grand total of 224 tons of materials is handled for each ton of finished product delivered to the ultimate consumer.

It seems probable that the above exceeds the average for products of our factories, and is obviously excessive for the products of farm, forest, and mine. Nevertheless the true averages, if ever ascertained, will no doubt be impressive in the extreme. Railway and ship loadings probably represent the closest approximation available, and it is estimated that in transportation alone 2 1/2 tons are handled for each ton transported. This makes it evident that any cost reductions in handling materials due to improved methods will mean a great ultimate saving in the cost of goods to the ultimate consumer.

GRAVITY

The attractive force that exists between the earth and all bodies at or near its surface is called "gravity." Weight is due to gravity. A body has weight because it is pulled downward by the force of gravity, and the amount that it weighs is a measure of this pull. A piece of iron, for example, weighs one pound when it is of such a size and density that it is drawn to the earth by a force equal to that which attracts a standard pound weight. The weight of a body (that is, the force by which it is attracted to the earth) varies slightly with the locality. Thus weight varies with altitude. A body weighs the most at the surface of the earth, as the attraction is there the strongest. Below the surface its weight decreases in the same ratio that its distance from the center of the earth decreases. Above the surface, the weight decreases in the same ratio that the square of the distance from the center increases. Weight also varies with the latitude, or distance north and south of the equator. In passing from the equator to either pole, the attraction of gravity increases by 1/568 of its original amount. This is due to the fact that the earth is not a perfect sphere, the polar diameter being 26 miles shorter than the diameter at the equator. At the poles, however, a body would actually weigh more than this, or about 1/193 more than at the equator. The difference, 1/289, is due to the rotation of the earth on its axis, the effect of which is to produce a force directly opposite to that of gravity (centrifugal force), which is greatest at the equator and diminishes in moving from it, until at the poles it becomes zero.

SKIN-DRIED MOLDS

Green sand molds are said to be skin-dried when only the interior surface is dried. This may be done to avoid the use of dry sand or loam molds, or, in some cases, because the sand used requires drying in order to withstand the heat and "wash" of the metal. Molds that are to be skin-dried should have a facing sand that will withstand drying like a dry sand mold. The facing sand is backed with ordinary heap or floor sand.

IGNITION TEMPERATURES

The temperature of ignition is the degree of temperature at which a substance will combine with oxygen at a rate sufficiently rapid to produce a flame. The temperature of ignition has often been regarded as the temperature at which chemical combination begins, but this is not correct, because chemical combination has begun before a flame appears. The following temperatures are required to ignite the different substances specified: Phosphorus, transparent, 120 degrees F.; bisulphide of carbon, 300 degrees F.; guncotton, 430 degrees F.; nitroglycerin, 490 degrees F.; phosphorus, amorphous, 500 degrees F.; rifle powder, 550 degrees F.; charcoal, 660 degrees F.; dry pine wood, 800 degrees F.; dry oak wood, 900 degrees F.; illuminating gas, 1110 degrees F.; benzine, 780 degrees F.; petroleum, 715 degrees F.; gas oil, 660 degrees F.; machine oil, 715 degrees F.; coal tars, 930 degrees F.; and benzol, 970 degrees F.

CALIDO

Calido is an alloy containing nickel and chromium and a small quantity of iron, which is used for resistance wire in electrically heated devices on account of the fact that it can be subjected to high temperatures without losing its resisting qualities. Its maximum working temperature is about 1100 degrees C. (about 2000 degrees F.). It melts at about 1550 degrees C. (about 2800 degrees F.).

VULCANITE BONDING PROCESS

In the vulcanite process for grinding wheels, the abrasive grains are bonded by the use of vulcanized rubber. Very hard, tough, thin wheels can be produced in this way, but they are expensive. Vulcanite wheels, like those of the elastic type, are made very thin, and are adapted for cutting off tubing, wire, thin sheets of steel or brass, and parts that are difficult to hold for cutting by regular tools. For general cutting-off operations, when the speed of cutting is not an important factor, vulcanite wheels are generally considered preferable to elastic wheels. The latter, however, can be used to better advantage for cutting off tempered tool steel or alloy steel tools, when cool cutting is important, because of their softer grades and cooler grinding action.

ISOMETRIC PROJECTION

In ordinary mechanical drawing, the orthographic method of projection is used, the object being represented in two or more views in which all lines are drawn to the same scale. Another system of representing objects, known as "isometric projection" is used to show in one view the appearance and the dimensions of an object in all directions; that is, to show both length or height, breadth or width, and thickness. The isometric method of projection differs from perspective drawing in that it shows the object in its true dimensions, all lines in any given direction being drawn to some given scale, and all lines that are parallel in the object being shown parallel in the drawing. The perspective drawing, on the other hand, shows the object as it would appear to the eye, the lines converging toward a common vanishing point.

YIELD POINT AND ELASTIC LIMIT

In making a tensile test, when the elastic limit is reached, the specimen will suddenly elongate, the pull will be reduced, and the beam of the testing machine will drop and rest on the bottom of the gate. This point is not the real elastic limit, but the "commercial" elastic limit or "yield point." However, in ordinary work, this is the value entered in the report. The real elastic limit is the highest value at which the load and elongation are proportional, and actually occurs somewhat earlier than is indicated by the "drop of the beam."

HUNTING TOOTH

When one of two meshing gears is provided with one more tooth than it would have if the numbers of teeth in the two gears were in an even ratio to each other, this extra tooth is commonly known as a "hunting tooth." For example, if a driven shaft is required to revolve three times as fast as the driving shaft, this result could be obtained by using driving and driven gears having 72 and 24 teeth, respectively. Instead of using this exact ratio, many millwrights, when installing cast gears, would use a driving gear having 73 teeth instead of 72, and a driven gear of 24 teeth. These numbers are very close to the desired ratio, but, as they do not have a common divisor, each tooth of one gear will mesh with all of the mating teeth one after the other, instead of meshing with the same teeth continually. The theory is that when the teeth mesh progressively in this manner, thus distributing the wear, all of the teeth will eventually be worn to some indefinite, but comparatively true, shape. To illustrate the action, any two teeth which happen to meet during the first revolution will be separated by one tooth space at the completion of the second revolution, by two tooth spaces at the end of the third revolution, and so on; consequently, one tooth may be said to "hunt" the other, and hence the name "hunting tooth."

STRAIGHT-FIXTURE PIPE THREAD

The special straight-fixture pipe thread consists of a straight thread of the same pitches as the American standard pipe thread, but having the U. S. standard form. This thread, as its name implies, is used for fixture work to hold parts together, but not to make tight threaded joints. The male thread is assembled with a standard taper female thread, while the female thread is assembled with a standard taper male thread. This thread is used on lighting fixtures and work of a similar class when it is desired to have the joint "make up," or stop, on the thread. The gages used are straight-threaded limit gages.

CABLE

A cable, generally, is a hemp, Manila, or wire rope twisted together from a number of different strands. In electrical engineering, a cable is defined by the Bureau of Standards as (1) a conductor of electric current, composed of a group of wires, usually twisted or braided together; or it may consist of (2) a combination of conductors insulated from one another, generally known as a "multiple-conductor" cable. The component conductors of the second kind of cable may be either solid or stranded, and this cable may or may not have a common insulating covering. The first kind of cable is a single conductor, while the second is a group of several conductors. The term "cable" is applied by some manufacturers to a solid wire heavily insulated and lead covered; this usage arises from the manner of the insulation, but such a conductor is not included under the Bureau of Standard's definition of "cable." Cable is a general term, but, in practice, it is usually applied only to the larger sizes. A small cable is called a "stranded wire" or a "cord." Cables may be bare or insulated, and the latter may be armored with lead, or with steel wires or bands.

INCH-POUND

Torsional tests are made to ascertain the elastic limit and the ultimate torsional strength. Since the strain varies over the sectional area, it is not possible to express the torsional strain as "pounds per square inch," but as "inch-pounds." The latter value is obtained by multiplying the pull applied by the lever arm through which it acts. For instance, assume that a wrench were gripped on a pipe; then, if a pull of 100 pounds is exerted on the wrench at a distance of 10 inches from the center of the pipe, the torsional strain on the pipe would be $10 \times 100 = 1000$ inch-pounds.

RADIAN

A radian is the unit of measurement of angles in what is termed "circular measure." In practical work, angles are always measured in degrees and minutes, but, in theoretical investigations and in formulas relating to revolving bodies, circular measure is often employed. A radian is the angle at the center of a circle which embraces an arc equal in length to the length of the radius of the circle. The value of a radian in degrees equals $180 \div \pi = 57.2958$ degrees. In circular measure, π denotes an angle of 180 degrees, and $\pi \div 2$, an angle of 90 degrees. It is especially convenient to measure angles in radians when dealing with angular velocity, because, in this case, a very simple relationship is obtained between angular velocity, linear velocity, and the radius of the revolving body. This is the reason for using the radian as a unit of angular measurement. If ω = angular velocity per second of revolving body, in radians, v = velocity of a point on the periphery of a body, in feet per second; r = the radius, in feet; then $\omega = v \div r$.

JAPANNING

Japanning is a process that consists of applying an opaque, usually black, varnish to the surface of the object to be japanned, and baking it on the surface by means of high temperature in a japanning oven. The art of japanning originated with the Japanese; hence, the name. The Japanese made their varnish or liquor from the secretions of certain kinds of trees. These, upon being exposed to the air, assumed a deep, dark color, to which pulverized charcoal was then added. The varnish so made was applied to the surface of the object to be coated in several successive coats. Each coat of varnish was baked on the surface in the sun before the next coat was applied. After the final coat had been baked on, it was polished, thus producing a smooth, glossy surface. The modern methods of japanning are different in everything, except the principle, from the methods used by the Japanese. The japan varnish used at the present time in manufacturing processes is composed generally of asphaltum, gum, linseed oil, turpentine, benzine, and some coloring matter, such as charcoal or boneblack. Objects may be coated with japan for several purposes: (1) To protect them from corrosion (rusting or tarnishing); (2) to protect them against chemical action, decomposition, or decay; and (3) for decorative purposes.

LEVELING ROD

One of the instruments used in surveying is the leveling rod. It consists of a wooden rod, usually 6 1/2 feet high, graduated to hundredths of a foot, and provided with a sliding target. The rod is made in two parts, so arranged that its length can be extended to 12 feet. The target is provided with a vernier for accurate work, reading to thousandths of a foot. In using, the rod is held in a vertical position with its lower end resting upon the point, the elevation of which is desired, and the target moved up or down until its center coincides with the cross-wires of the telescope of the level. The reading of the elevation is made from the rod on a line corresponding with the center line of the target. There are several forms of rods in common use, some of which are read by the rodman, while others are read through the telescope of the level.

NITROGEN

Nitrogen is a gas that forms approximately 79 per cent by volume, or 77 per cent by weight, of the atmosphere. The specific gravity of nitrogen (air = 1) is 0.967, and its atomic weight, 14.01. It liquefies at a temperature of —194 degrees C. (—317 degrees F.), and solidifies at a temperature of —210 degrees C. (—346 degrees F.). Its specific heat equals 0.244. Nitrogen neither burns nor supports the combustion of ordinary combustible materials. Nitrogen is produced in large quantities from atmospheric air in the commercial manufacture of nitric acid and nitrates.

JAPANESE ALLOYS

Metal alloys used for Japanese art work are composed mainly of copper with a number of other metals. One analysis shows 94.5 per cent of copper; 3.7 per cent of gold; 1.5 per cent of silver; 0.1 per cent of lead; with small percentages of zinc and iron. Another alloy is composed of 67.3 per cent copper; 32 per cent of silver; and 0.5 per cent of lead; with small percentages of gold, zinc, and iron. Another easily fusible metal for casting in plaster-of-paris is composed of 91.4 per cent of copper; 5.7 per cent of tin; and 2.9 per cent of lead. The term "Japanese alloy," therefore, does not signify any one composition.

What MACHINERY'S Readers Think

on Subjects of General Interest in the Mechanical Field

ARE SKILLED MECHANICS SCARCE?

There has been a great deal of discussion, pro and con, in the trade and technical press during the last two years in regard to an alleged shortage of skilled mechanics. It is stated by some that there is a distinct shortage of skilled mechanics because our apprenticeship systems do not turn out a sufficient number of skilled men. Others deplore the fact that many mechanics are leaving the machine industry, and ask "What are we going to do about it?" We are told that the machine business is facing what amounts almost to disaster and that unless measures are taken to increase the supply of skilled men, a very difficult situation will result.

In spite of this alleged shortage of skilled men, it appears that the machine-building and metal-working industries as a whole made a new high record for production in 1925. How could this have been accomplished if the industry were crippled through the lack of skilled men? I question the claim that the industry is facing anything like a crisis from this source. Most of the writers discussing this question fail to present specific evidence supporting their claims. A few examples probably could be cited, but, personally, I do not know of a single shop that during 1925 was embarrassed by this supposed shortage of experienced mechanics. On the other hand, I know of many skilled men in the machine industry who have unsuccessfully looked for jobs commensurate with their skill for several years.

Even during the war there was no real shortage of skilled men, but there was a great deal to be desired in the way of placing the skilled men in the positions where they would be of the greatest value. This statement I believe to be true not only where the Government was the employer, but in many other instances. There was at that time a great waste of human energy, and, as has been pointed out by what is now known as the American Engineering Council in its report on waste in industry, there still is a great deal of waste of human energy. I believe that instead of a shortage of skilled help, there is largely a waste, unavoidable though it be, of skill and experience, because industry is not at all times in a position to take advantage of the skill that is available.

H. L. Wheeler

IS A FOOL-PROOF SAFETY DEVICE POSSIBLE?

I saw a safety device lately that showed how difficult it is to think of everything that may happen, and how easily a safety device may become a man-trap if the machine is not used in just the way the designer has in mind. The device was intended to protect the operator of a punch press. It worked in the usual way, compelling the operator to use both hands to release the tripping mechanism before he could push down the treadle with his foot.

The device was all right when the machine was used for work that could be fed through automatically, but when used for work that had to be placed by hand for each stroke, it did not act as a safety device at all, because there was nothing to prevent the press repeating if the operator held down the treadle a half second too long. This was more than likely to happen, and then the punch would come down again just as the operator's hands were busy removing the finished piece.

The press makers may have remedied this defect, but the device I saw was apparently standard equipment, and was only a few years old. In this case, the tripping mechanism was rearranged so that the first turn of the crankshaft would release the pawl, leaving it free to snap back into place and stop the press whether the treadle were held down or not. Many old presses had this kind of release, but did not have anything further for the protection of the operator.

Thinking a little further in this direction, it appears that to leave the pawl free to snap back into place is only another step toward absolute safety. The pawl spring may break, nullifying all effort for safety. The next step might be to provide a secondary pawl which would be actuated by the movement of the regular or primary pawl, so that if the treadle were held down too long, or for any other reason the regular pawl failed to get back into place, the secondary pawl would still be in the way ready to stop the crankshaft at about three-quarters of the way around.

Such an arrangement would put it up to the operator to release the treadle instantly, or spend some time getting things untangled and ready to start again. But the device I saw required him to release the treadle instantly to prevent the press repeating, which was worse still. Any device to prevent repeating must have adjustment to allow for continuous running, and here we have to depend upon the human element again. Who will be thoughtful enough of his own safety to reset the safety mechanism when the machine is set up for a new job requiring each piece of work to be placed in the die by hand?

R. B. Willis

DUTIES OF FOREMEN

In the mechanical industries, the working forces may be roughly divided into two main divisions. First, the skilled mechanics who make the tools or machines for the production departments, and, second, the operators who make use of these tools and machines in production work.

In the first of these two main divisions, consisting mainly of skilled mechanics, I believe that it has worked out most satisfactorily to limit the duties of the foremen to the planning of the general routine of the work, distributing it among the men to the best advantage. He then spends the rest of his time working on a specific job like the other men.

In the case of production departments, the duties of the foremen are quite different. Here the results of the work do not remain permanently in the shop, as in the case of tools or machines, and immediate inspection of all work is necessary; hence, the foreman of a force of operators in the production department must devote all his time to supervision. He must also have full charge of the men and have authority to hire and discharge them.

In the case of the skilled mechanics, the hiring and discharging can be best done by the management of the shop, rather than by the foreman. The rates of payment, of course, in either case would be set by the management.

O. L. H.

DECIMAL EQUIVALENT TABLES ATTACHED TO MACHINES

Few men in the machine shop know the decimal equivalents of the common fractions without looking up some table or referring to a micrometer, which may not always be at hand. Besides, many micrometers over 2 inches do not have decimal equivalent tables stamped on the frame. The writer suggests that in order to save the time of the shop man in looking up decimal equivalent tables, a simple plate similar to a nameplate or the speed-change plates be attached by the manufacturer directly to the frame of the machine. This would not greatly increase the cost, and would save a great deal of time in the shop.

Albert Guth

Determining Shop Costs

Relation of Cost System to Charge for Work—Practicable Methods of Ascertaining Cost of a Job

By JAMES ALLEN THOMAS

THERE are a surprisingly large number of machinery manufacturers who consider a thorough and complete cost system just so much additional expense in running the business without showing anything in the way of visible, profitable returns. The remarks and observations which follow are based on many years experience in all departments of several factories that were engaged in the construction of heavy machinery of very diversified lines—engines, boilers, mining and crushing machinery, etc.

When the owner or manager of a machinery manufacturing establishment is in personal touch with the shop operations, he is likely to think that, as few items of cost are incurred without his direct supervision, the necessity of a well organized cost accounting system is nil. He sees where most of the money goes, as he knows exactly what is purchased, and has a rough idea of the length of time it takes a workman to do a certain job. Since the man is working under his direct supervision, he concludes that the job is done about as quickly as it could be done.

The "Time and Material" Basis of Charging for Work

If work is charged for on a "time and material" basis, it is easy to keep a good enough account so that the invoice for the work can be made out. But if work has been done on a contract basis, and if the owner has suffered a loss, there is no cost system that will reimburse him for that loss. In the jobbing and contract shop, particularly, the cost system will be found necessary. When the job is taken on a "time and material" basis, it is not so necessary to have a well organized cost system. Whatever the job cost, plus the desired profit, may be charged up to the customer. Should the charge be too much, the customer may take his subsequent work elsewhere; the loss of his patronage may not even be suspected.

It may be that a proprietor who considers a cost system superfluous, has a competitor on the other side of the town who has such a system, and knows exactly where his money goes; thus he is able to cut costs so as to beat competition, and also keep his "time and material" customers because he can show them that he has done their work economically as far as labor cost is concerned. The "time and material" basis is a good one for the manufacturer under any shop conditions, so far as assurance against loss is concerned, but unless the shop is a well managed one, it is a poor basis for the customer. Usually no matter how efficiently the work is done, the customer thinks he is getting the worst of the deal, having but a vague idea of what is required, the time it should take, or contingencies that might arise in connection with the work. For instance, the time consumed is liable to be a fruitful source of dispute between the manufacturer and the customer. And unless the former can show pretty conclusively that there has been no overcharge of time, or time wasted on the job, he is likely to be at a great disadvantage.

Advantages of a Contract Price

As a general rule, it is much more satisfactory to do work for a contract price; then there can be no dispute about the charge. This may not be so profitable to the manufacturer—and it will not be unless he understands estimating—but the customer knows in advance just what he has to pay. It is practically impossible to figure the cost of some jobs in advance, and there is always the possibility of contingencies arising that cannot be foreseen. It is just that the customer should take all the risk of cost on such work, and the shop is justified in refusing to do the work on any other than a "time and material" basis. Incidentally, it behooves the customer with this kind of a job to look up a shop that has a reputation for efficiency.

If a shop has a monopoly on the local business and is the only one having the capacity required, the proprietor can charge what he likes for the "time and material" job, but if this plan continues, competition is invited, and perhaps after years of work, there are no records upon which to base estimates when bidding for work against the same competition. Customers have been overcharged, the new competitor gives good and intelligent service, and the old-timer is soon out of business and broke, unless he voluntarily quits in time after seeing the handwriting on the wall.

The principal reason for this man's failure is lack of a system to keep track of costs and show whether the charges have been excessive for some work and not enough for other work. There have been financially successful shops that operated without a cost system for many years, but they were always removed from keen competition and were permitted to make excessive charges. As a general proposition, more attention should be paid to detailed estimating and detailed cost accounting.

Determining the Cost of a Job

The cost of a job includes more than the cost of the material and the wages paid for the work done on the material. The total cost includes material, wages, and overhead expense. The latter item comprises everything in the way of expense for operating the plant that cannot be directly charged to the work done. It is just as important to include the overhead expense in the cost of the work as it is the wages. Sometimes it is even more important, for the overhead expense will, under some conditions and for some classes of work or for some departments, often exceed the labor cost.

For taking care of ordinary cases and getting a general cost result, when cost of details or separate parts of a machine are not desired, it is unnecessary to have an elaborate system of keeping costs. The cost system must have the necessary facilities for recording the workman's time and some method of keeping account of the material used. It must also have some way of properly apportioning the overhead expense so it may be added into the cost account in order to give the actual cost of producing the work. The result thus secured will cover the total cost of the job and give none of the details of cost. Such a result will permit setting a proper price on the work done. It will also be of assistance in the future in estimating on the same kind of job.

This kind of result will be a pretty fair guide, if used intelligently, for setting prices on future work of a similar class when the size, weight, and class of finish do not vary too much from the original job. Under this system of cost keeping, a general result is all that has been secured, and within its limitations this system is useful and better than none at all. It does not cost much to get such a result, but it is useless in figuring on any other class of work, even though some of the component parts of the job are used in the new work.

An important factor in the matter of overhead expense is keeping account of the non-productive labor or labor that is not chargeable directly to salable work, but rather to overhead. This item is likely to become excessive unless watched very closely. It is wastage, constituting the same kind that takes place in the matter of oil, files, drills, etc., when care-

lessly used, and it frequently becomes excessive unless closely watched and controlled.

A cost account can never be absolutely correct. There are too many opportunities for undiscoverable mistakes to creep in. Time may not be accurately reported or charged, particularly when small amounts are involved, and there is a great liability of mistakes in weighing material. However, these errors will not be serious or influence the cost account enough to invalidate it or make it useless as a basis for charging for work.

Should Scrap Value of Chips be Credited to a Job?

The rough weight of an iron casting is the proper weight to be charged to a job, as the material removed in finishing such a casting has little or no value, and is not worth weighing up and calculating. However, when the material from which the casting is made is of considerable value per pound like bronze, brass, aluminum, etc.—and the amount removed is considerable, it may be expedient to credit the job with such material at its scrap value. When the amount removed in finishing is not sufficient to make this credit worth while, the scrap may be accumulated and its value credited to some account and charged to the foundry at scrap value. This credit will consequently be reflected in a lowering of the overhead expense of some department, and the material must be charged or it will not get into the cost account of the job on which it is used. As it costs something to gather valuable scrap in small quantities and store it until a worth-while amount has accumulated, it will be well to credit the amount to cost of cleaning up the shop.

If the scrap material is pure aluminum or pure bearing metal of a known quality, it will be possible to return it to the stock-room and credit it at full value. If it is bronze of even a known mixture, it would seldom be permissible to give credit for full value, as frequently the specifications under which the alloy is made call for the use of virgin metals.

When the material is steel or iron for a forging, the weight of the machined or rough forging may not be the proper weight to charge. If the forging should be made from a piece that is too large, thus leaving a piece of useless scrap, the entire piece must be charged in making up the cost. A good blacksmith will minimize the amount of scrap left from forging by selecting a proper size piece to start with. Likewise a good patternmaker will minimize the amount of stock of valuable material to be removed in finishing a casting made of alloy.

A piece of material may have lain in the scrap pile for a long time and have been carried as such in the inventory, but when it is taken from there to be forged into a useful piece, it has ceased to be scrap, and for all purposes has become new material; hence it should be charged against the job as such. This applies to other kinds of scrap as well.

The amount of valuable alloy material to be charged or credited to a job, must be left in large part to the discretion of the foreman of the department, and the disposition of it left in his hands. The charging out of such material and the pricing of it falls upon the store-keeper's department, which is responsible for receiving and issuing it.

Charges when Castings or Forgings are Spoiled

The cost of castings and forgings spoiled after being made should not be charged to the job. They should be charged to the overhead of the department in which they were spoiled, and the material credited to that department at scrap value. Replacements of bad castings and spoiled material should be ordered in such a way that the cost of the pieces replaced cannot be added to the cost of the job. The cost of the original pieces should be so handled that they will be added to the overhead expense of the proper department. This is important, and any other method of charging would be unfair; it would be palpably unfair to charge spoiled material to the cost of the job.

If machine shop work has been expended on a casting that proves defective, it is perfectly legitimate to charge such machine shop time to foundry overhead expense, but as this might unduly load up this account, some might prefer to charge it to general expense. At any rate, the job should not be made to bear the burden, as the customer cannot be justly charged with it. Besides, this defective casting expense might not occur on a future job. The writer believes it is proper to charge the cost of all mistakes to the department making them. Then when these charges become too great and too frequent, they should be investigated and the cause corrected.

Charges for Special Tools or Fixtures

When special tools, jigs, fixtures, etc., are made for a job and will never be used again, their cost should be charged to the job, and the material used in making them charged at its new value and credited at its scrap value, whether scrapped immediately or not. If these special tools can be made to serve on future work, only a portion of their cost may justly be charged to the original job, and this amount will have to be arbitrarily determined by the proper authorities. The cost of drawings should be handled in the same manner.

It is not the intention of the writer to intimate that a job should go through the shop and be charged with time and material or be credited 100 per cent perfect, as perfection cannot be attained; but it is desirable that a cost account should be as accurate as possible and represent the cost of a job when done under average shop conditions.

* * *

A WORLD AFRAID OF PRODUCTION

In the article by B. M. Anderson, Jr., in the *Chase Economic Bulletin*, attention is called to the peculiar state of affairs that makes men fear an addition to the wealth of the world—an addition which can only be made through increased production. The post-war world, in the opinion of the author of this article, has developed an absolute obsession—a fear of production. For the last century and a half, power machinery and a constant succession of mechanical inventions have been bringing luxuries to the masses of men unknown to the kings of earlier generations. Consumption has kept pace with production. Our 100,000,000 people consume vastly more than the 400,000,000 people of China—because they produce more, and so can afford to consume more. And yet we fear reviving production in Europe, and fear to let Europe send us goods to pay her debts to us. Labor fears production. English labor systematically resists new labor-saving inventions, and holds down output on the theory that if all the work is done today there will be none to do tomorrow. It is easy for the business man to see the fallacy of this. But he may easily be carried away by a similar fear that if imports come in they will use up domestic demand, and leave just so much less demand for domestic products. Both err in failing to see that demand itself expands and grows with production and trade. Supply of one product constitutes demand for other products. Imports constitute a demand for exports.

Imports coming in as payment for debts do not lessen domestic demand for domestic products. Rather, they increase by an equal amount the buying power of the country. If French goods are sold in our market, and the dollar proceeds turned over to our Government, our Government may do one of three things: (1) It may remit taxes, permitting our people to buy more goods; (2) it may pay off public debt, increasing the funds in the capital market to be invested and spent; or (3) it may engage in increased governmental expenditure, which again increases the total volume of demand in the country.

* * *

Awards totaling $17,651 were paid to 1728 employes of the General Electric Co. during the six months ending June 30, 1925, for suggestions that increased the efficiency of the company's operations. The suggestions ranged from safety devices for the protection of workers to improved methods of manufacturing, and the individual awards ranged from one to five hundred dollars.

Comparing Equipment and Methods for Quantity Production

By E. P. BLANCHARD
Bullard Machine Tool Co., Bridgeport, Conn.

Methods Used in Studying the Economy of Different Production Methods so that the Most Efficient Equipment for Producing Given Quantities may be Selected

PRODUCTION economy depends directly upon the efficiency of the method of manufacture. In some cases, the equipment is more or less incidental to the method, while in other cases the equipment and the method are so closely identified that one cannot be considered without the other. In any case, however, an intelligent selection of the equipment and the methods to be used can be made only by a careful comparison of all the conditions incident to each method and each type of equipment, and by cost comparisons for different quantities to be produced. One of the most interesting points brought out by such a comparison is that different quantities per day often require the use of entirely different methods and equipment to attain the most economical production. For each type of machine and for each method there is a zone—determined by the number of pieces required per day—within which a particular method will give the highest efficiency.

The Most Efficient Method Depends on the Quantity to be Manufactured

One of the main objects of standardization and mass production is to obtain economy of manufacture. This is important in many manual operations, but is still more important when machinery replaces manual effort and skill. Nevertheless, the methods that are highly economical when great quantities are produced may be very expensive for small quantities. The first fact to be emphasized, therefore, is that every process and every type of equipment has some zone in which it is most effective and in which economy, with that particular equipment, reaches its peak. When the production is either greater or less, some other method may gradually become better adapted for the work. It is seldom that two methods for the same class of work are equally economical for producing equal quantities, and therefore, two machines or methods that appear to be close competitors may not, in reality, be directly competitive; however, the problem of selecting one or the other for a given set of conditions may be comparatively simple when all the facts in the case are reduced to a comparative basis.

There are a number of reasons why it is difficult to obtain exact information for publication, on which to base a direct comparison between two machines and methods. Only in a few instances can this be done fully and completely. The reasons why such comparisons are seldom published are because (1) the equipment of competing manufacturers is generally involved, and business ethics do not permit a thorough discussion; (2) it is often impossible to obtain complete details of all the underlying facts; (3) manufacturers sometimes hesitate to make a comparison between results obtained from their own past equipment and those of newer methods, because they do not wish to make customers feel dissatisfied with equipment previously sold to them, if it is surpassed by later developments; (4) the users of highly developed equipment and methods of production prefer to keep to themselves the economies they have obtained through no small cost to themselves, and they are not eager that others should take advantage of the same economies.

The present article is based on a comparison of equipment built by the same manufacturer, and all the items of expense are reduced to common factors. Such an opportunity for comparison is not often presented, and it is therefore believed that the recording of these facts will be of great interest to mechanical men engaged in quantity production.

Machining Flywheels by Two Different Methods

The vertical turret lathe has been used by the automotive industry to a large extent in the past for the machining of flywheels. Recently a more highly developed machine for this work has been introduced, the "Contin-U-Matic," built by the same manufacturer. An excellent opportunity presented itself a short time ago for comparing these two types of machines in production work.

An automobile manufacturer urgently needed flywheels before a machine of the continuous type could be completed, and the machine tool builder met his requirements by setting up in his own plant a battery of vertical turret lathes and machining the flywheels in his shop until the continuous machine could be delivered. Later, when the continuous machine was completed, flywheels were produced on it in the builder's own plant as well. The latter machine is a four-unit type, producing in four consecutive chuckings the same wheel as a battery of four vertical turret lathes had pro-

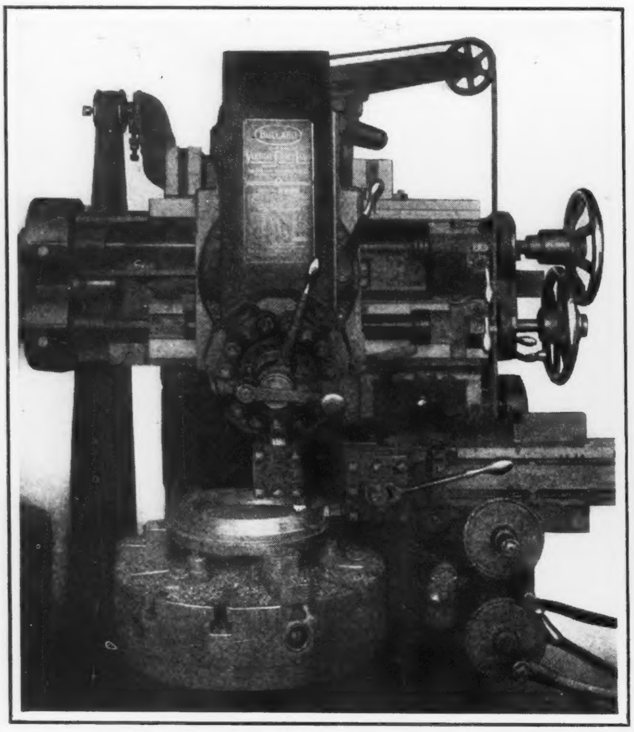


Fig. 1. First Chucking in the Vertical Turret Lathe—roughing the Clutch Side of the Flywheel

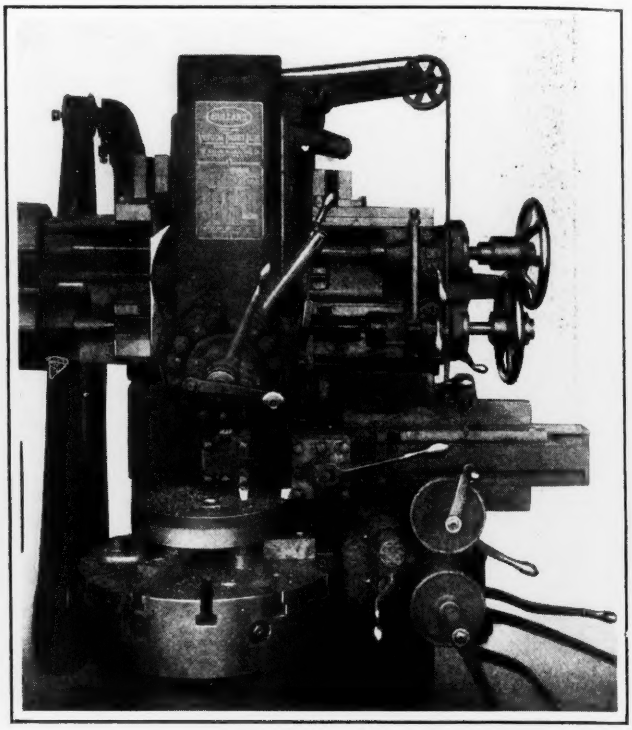


Fig. 2. Second Chucking in the Vertical Turret Lathe—roughing the Engine Side of the Flywheel

duced. Hence, a completely machined product was made under exactly the same conditions, by two different types of equipment. This furnished an unusual basis for a direct comparison of the methods.

The heading illustration shows the battery of vertical turret lathes at work, while Figs. 1 to 4 show the set-ups for each chucking of the flywheel. Fig. 9 shows the continuous four-spindle machine in operation, and Figs. 5 to 8 show the tooling arrangement of each of the four units or spindles of the continuous machine.

How the Costs of the Two Methods were Compared

The costs of the two methods, recorded in the accompanying table for productions varying from 40 flywheels per day to 140 flywheels per day, which latter figure constitutes the total productivity of the continuous machine, were obtained as far as possible by eliminating all pro rata items of expense and reducing them to specific known items of cost. The items considered include the investment in machinery, tools, and accessories, and in power units. They include an allowance for the floor space required for the machine, operators, and for an accumulation of work in process. While the maintenance service and the cost of repairs could not be accurately determined in the cases studied, because production was not carried on for a sufficient period of time to furnish conclusive data, the figures used in the comparison are based upon the average experience of several other installations over a long period of time. The labor cost was avail-

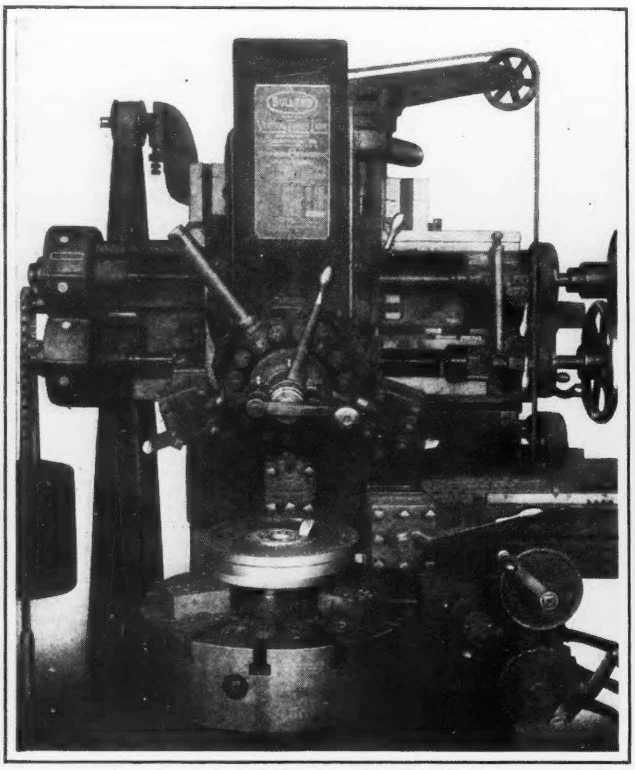


Fig. 3. Third Chucking in the Vertical Turret Lathe—finishing the Engine Side

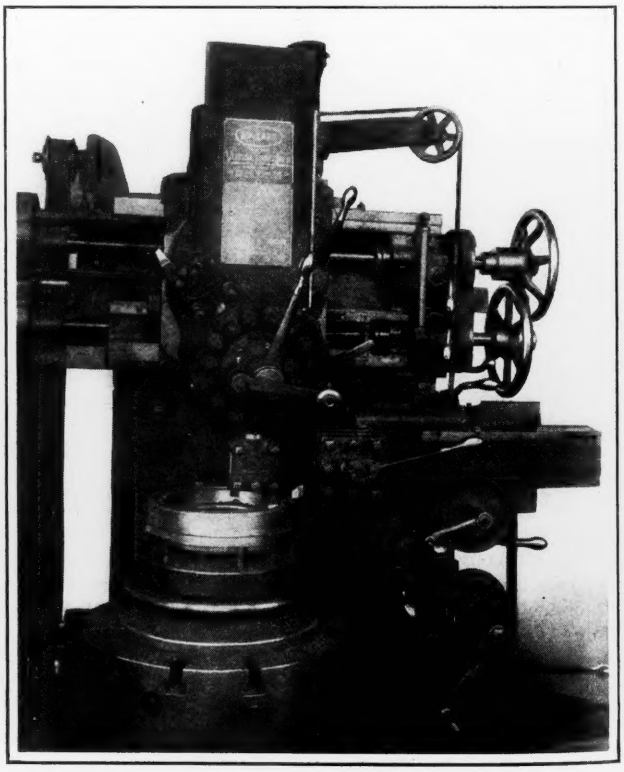


Fig. 4. Fourth Chucking in the Vertical Turret Lathe—finishing the Clutch Side

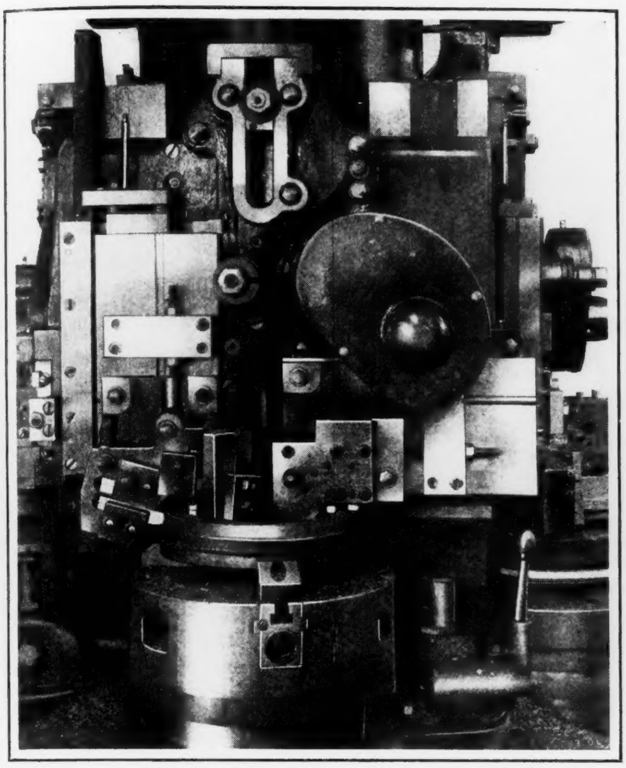


Fig. 5. First Unit of Continuous Machine—roughing the Clutch Side

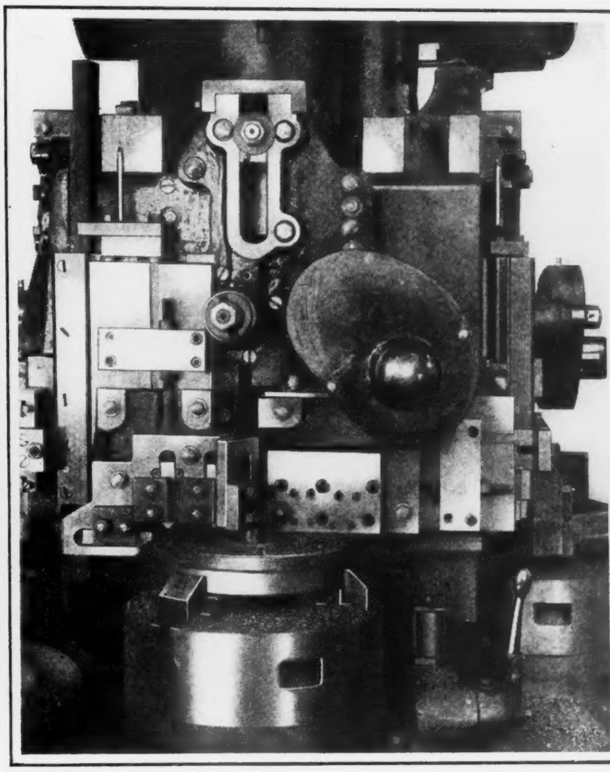


Fig. 6. Second Unit of Continuous Machine—roughing the Engine Side

able and comparable for both types of machines. The cost of supervision was based on a percentage of the labor cost.

In figuring interest on the investment, depreciation, taxes, and insurance, the same rates, of course, were used in both cases. In figuring the floor space factor, consideration was given to the items of rent, heat, light, and the distribution of the expense of related non-productive space over the entire productive areas. Power consumption and labor costs were based on actual conditions, and the cost for the customary tool-setters and inspectors was included. The total of all the expense items was divided by the actual production, so that the final comparison was expressed in terms of cost per piece, as will be seen from the table.

It is obvious that some items of expense would be exactly proportional to the production, as for instance, the cost of replacing cutting tools, and the labor required for handling the product. The final cost figures per piece, therefore, do not constitute the total cost in each case, but do give a direct comparison between the cost of the two machining methods, for equivalent work.

In the table, the actual rates used in the cost calculations have been omitted, as these may vary in different plants and under different conditions. The important point is that the same factors were used in considering both types of machines and that these were the actual costs obtained in the plant where the costs were observed. The interest on the in-

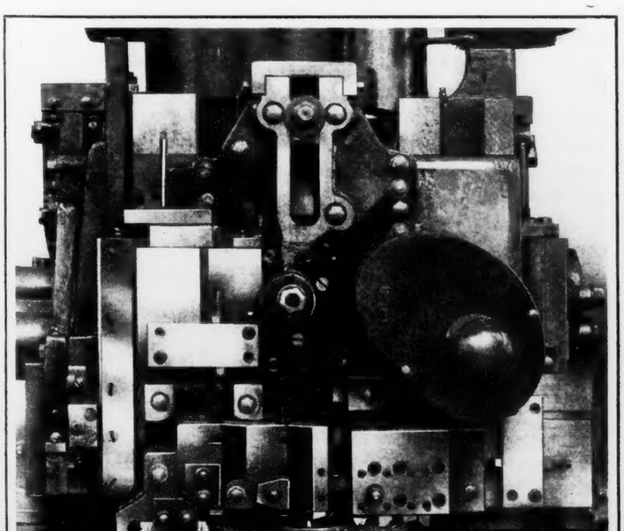


Fig. 7. Third Unit of the Continuous Machine—finishing the Engine Side

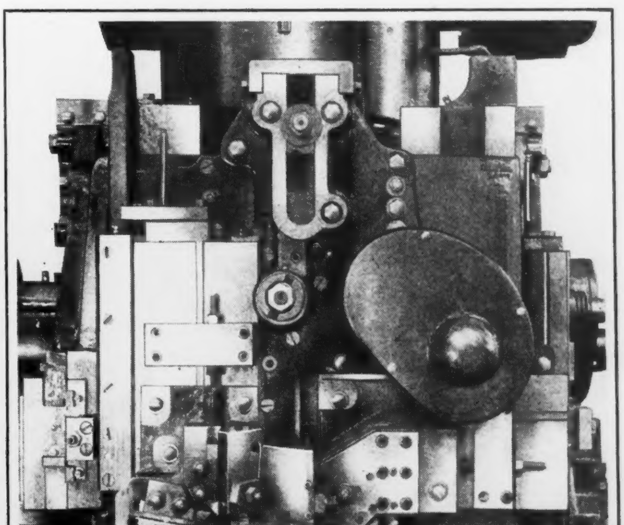


Fig. 8. Fourth Unit of the Continuous Machine—finishing the Clutch Side

vestment was figured at 6 per cent and the depreciation at 10 per cent, these figures being fairly universal in all plants.

The Results of the Investigation

A study of the items of cost charged against production naturally divides these items into several classes: (1) Those that are fixed or constant, because they are based on the investment factor and figured on a yearly basis; (2) those that vary in proportion to the time during which the equipment is used; (3) those that vary in proportion to the production; and (4) those that vary in accordance with general plant conditions. It would be difficult to make use of a formula that would take all these items into account, and such a formula would be, at best, only approximate.

In the case under consideration, the costs were first determined on the basis of actual daily production. The four vertical turret lathes produced 90 wheels per 9-hour day. This figure checks very closely with the production obtained in other plants. The production cost per flywheel on this basis was 69.2 cents per wheel. The continuous machine, employing the multiple-spindle method, with a production of 140 wheels per day, shows a cost of 23.9 cents per wheel. To obtain comparable figures for equivalent production, therefore, it was necessary to consider the cost if a sufficient number of vertical turret lathes were used to produce 140 wheels per day. On this basis, the unit cost by the vertical turret lathe method was 65.8 cents per wheel, as against 23.9 cents per wheel by the multiple-spindle method. At 90 wheels per day, the vertical turret lathe unit cost was 69.2 cents, as compared with 31.2 cents for the multiple-spindle method, the continuous machine in that case operating, as the table shows, only 64 per cent of full time. As the table shows, for 50 wheels per day the vertical turret lathe costs were 72.5 cents per wheel, and the continuous machine costs, 43.3 cents. Other quantities in the table were interpolated.

Obviously, the production of any quantity not requiring full-time production of the continuous machine, increased the cost per wheel, as the full amount of fixed overhead had to be distributed over a smaller number of pieces. With the

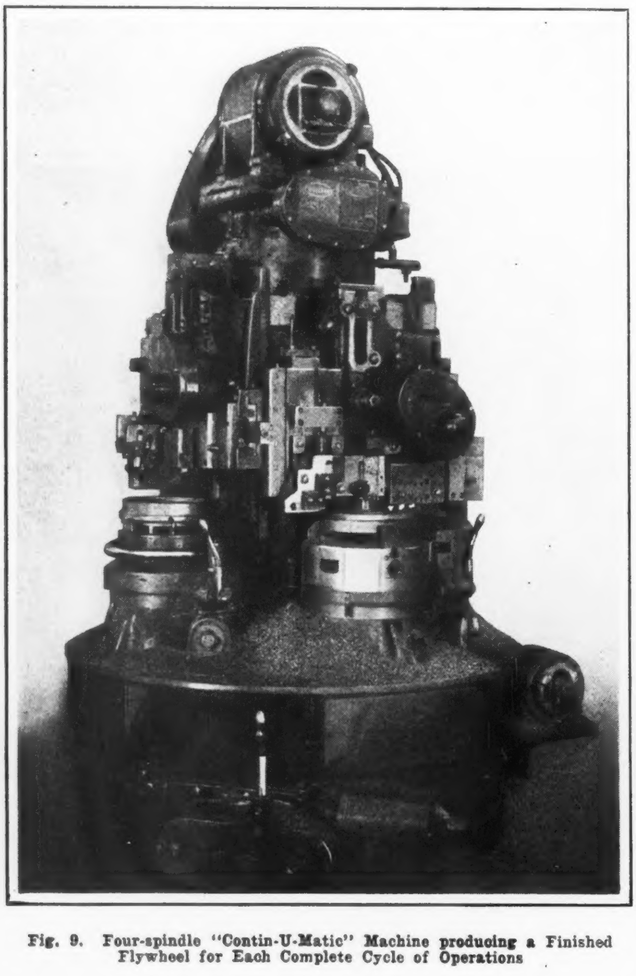


Fig. 9. Four-spindle "Contin-U-Matic" Machine producing a Finished Flywheel for Each Complete Cycle of Operations

COMPARISON OF PRODUCTION COSTS BY DIFFERENT MACHINING METHODS

Daily Production	Cost per Flywheel, Single-spindle Method, Dollars	Cost per Flywheel, Multiple-spindle Method, Dollars	Yearly Return on Difference in Cost of Equipment for the Two Methods, Per Cent	Yearly Return on Total Cost of Equipment for Multiple-spindle Method, Per Cent	Percentage of Full Time that Multiple-spindle Equipment is in Operation
40	0.733	0.450	43 1/2	13	28 1/2
50	0.725	0.433	.....	.....	35 2/3
60	0.720	0.387	61	23 2/3	43
80	0.706	0.333	207	36	57
90	0.692	0.312	.....	.....	64
140	0.658	0.239	.....	.....	100

Machinery

vertical turret lathes, the investment for smaller quantities can be reduced one spindle at a time to suit the demand, excessive burden thereby being avoided. But even by this method of economy in the case of vertical turret lathes, it developed that the unit cost for 50 wheels per day (a production which can be almost attained by two machines) is 72.5 cents per wheel, as against 43.3 cents by the continuous machine, which carries the full investment burden, although it is in operation only about 35 per cent of the time. As the quantities increase, of course, the margin in favor of the multiple-spindle unit increases.

Making Use of the Results of the Investigation in Selecting the Most Economical Equipment

The choice of equipment must be based either on the return on the total investment or on the return on the difference between the investments in two different types of machines—the marginal investment. The table shows that at a production of 40 wheels per day, the saving with the continuous machine, as compared with the single-spindle machines, is only 13 per cent of the total investment required; but it is 43.5 per cent of the difference between the investments in the two types of equipment. At 80 wheels per day, these figures are 36 per cent and 207 per cent, respectively. It is evident from this that the extra capital required for installing a continuous machine, as compared with single-spindle machines, would in that case be absorbed by the savings in approximately six months, and that the total investment of the machine would be entirely absorbed in less than three years—in considerably less than three years, in fact, because the cost figures from which these percentages are derived already include 6 per cent for interest and 10 per cent for depreciation.

It is dangerous for anyone to draw definite conclusions from the data presented, because the figures will vary with the conditions under which a manufacturer may be operating. The purpose of this article is simply to show that it is entirely feasible to make an accurate comparison between two different production methods, taking into account the greater or less production per day in different plants. It also shows that highly productive machines may be economical to use even though they stand idle part of the time. Many other conclusions may be drawn from a study of the table, but it is not within the scope of this article to examine all of these conditions. The purpose is simply to point to certain well established production principles, to suggest a more definite application of them, and to stimulate thought that may lead to the establishment of new principles in making a comparison of manufacturing methods.

* * *

In 1924 the railway operation in the United States was equivalent to 11,250,000 locomotive miles for each fatal accident to passengers, and 287,000 miles for each injured. A comparison of the railroad accident records of 1914 with 1924 indicates that the railroads are twice as safe as they were before organized safety work began. In 1914 one passenger was killed for every 6,620,000 locomotive miles of operation, and one injured for every 116,000 miles. Practically the same degree of progress has been made in the safety of employes.

The British Metal-working Industries

From MACHINERY's Special Correspondent

London, February 15

INFORMATION gathered from all the general sections into which the engineering industry can be conveniently divided reveals a steadily increasing stability and faith in the future. The position, however, cannot be regarded as entirely satisfactory until the shipbuilding centers have a quantity of work in hand more in proportion to their capacity. Viewed in the most favorable light, the shipbuilding industry appears to be under a cloud, and the reaction is felt in several sections of engineering industry. In spite of this, however, it is believed that the outlook for the engineering trade is steadily improving.

The Machine Tool Industry

In the machine tool field, there is little room for doubt that the present improvement has a much greater significance than has been attached to the previous and sporadic increases that have been noted during the last four or five years. Although a certain amount of over-time work is being done in some of the machine tool shops in the Midlands, generally speaking, the amount of work in hand is only just enough to keep the shops going steadily. In the Midland district, some machine tool firms have found a night shift necessary, and for many of the standard and special machines that are required for the automobile industry, deliveries are way behind. Drilling machines of all types, milling machines, and shapers are in good demand, while for turret lathes and screw machines some large orders have been received recently.

Among Yorkshire machine tool makers orders for the heavier classes of machines are largely confined to rolling stock and automobile production requirements. Australian, South African, and Indian railways continue to take a fair number of such machine tools. Great hopes of big business are being entertained from the reorganization of the railway shops in New Zealand. Added to this, the recent decision of the government to spend £10,000,000 on developments in the Crown Colonies will no doubt favorably affect home machine tool makers, since railway expansions will naturally constitute a considerable proportion of these developments.

Home railway orders for railway shop machine tools are generally for single machines only, but the flow of orders is fairly steady. Hydraulic presses and hydraulic machinery generally are in good demand.

Makers of surface grinding machines in the Yorkshire area are well occupied, a high percentage of orders being for export. Quotations for large quantities of machine tools for Russia have recently been sent in from this district.

Machine tool makers in the Manchester area find that the proportion of orders relative to inquiries is growing steadily. Horizontal boring and drilling machines are in fair demand, and this is true of nearly all types of grinding machines. Many of the machine tool makers in this area do business with textile machinery makers, and these show an increased activity. The textile machinery trades do not call for many machines of the highly elaborate automatic class, but require chiefly simple machines, built on standard lines, and developed for individual operations. Gear-hobbers have, at present, an increasing interest for some branches of engineering.

For Scottish machine tool makers, 1925 was a very trying period, but the outlook is now more favorable. Makers of machine tools for shipyards and marine engine and boiler shops, on account of the depression in shipbuilding, have had only a poor demand for their products. Orders from the Colonies and South America were largely responsible for any activity that was manifest during 1925.

Overseas Trade in Machine Tools

A sharp increase in the value and tonnage of exported machine tools was registered during December. Exports of machine tools reached a value of £147,760, an increase of nearly 50 per cent over the November figure, and the highest recorded last year, with the exception of February and March. The tonnage of machine tools exported during December reached 1435, a figure that compares favorably with 961 for November or 1098 for October. For December, the value per ton of exported machine tools was £103. Lathes figured prominently among the exports for December, amounting to £60,400, or about 40 per cent of the total. In no class of machine tools, were exports of less value or tonnage than imports.

Imports of machine tools, after a surprising jump in November, fell back nearly as suddenly in December, and more normal figures were again recorded. The figures were £72,254 for 435 tons, as compared with £97,970 for 764 tons in November, the latter figures suggesting an influx of machines of a low value per ton. For December the value per ton of imported machine tools was £166.

Beyond a definite tendency for imports to increase in value, the complete returns for last year show little on which to base an estimate of future business. According to the curves plotted from import and export figures, 1925 began and finished with an upward tendency, the summer showing a decided depression, and this official summary for the year 1925 corresponds with the general experience of most machine tool manufacturers.

General Engineering Field

Although impatience is sometimes expressed at the slow revival in engineering, the general impression remains that the progress has a sound basis. The holiday period at the close of the year—a frequent excuse for a falling off in business—did not cause any appreciable set-back, and the fact that, in most cases, reports show that orders are more easily obtained is the best justification for the sanguine hopes with which the year opened. Constructional engineers show a revival of activity after a falling off lasting for two or three months. Millwrights are not so busy as works extensions and similar developments would lead one to expect, but rolling stock builders continue to have well-filled shops.

Further important orders for rolling stock are expected from the Argentine and other parts of South America, and quotations for large numbers of cars for home railways which have recently been submitted are expected shortly to result in orders.

The shortage of work among large armament firms has had a serious effect on many of Sheffield's foundries and engineering shops, and until shipbuilding requirements increase, the position is not likely to improve. Rolling mill equipment is in fair demand for both home and overseas, and British makers have little difficulty in meeting Continental competition in this class of equipment. Colliery engineering firms have had a fairly busy time during the last few months, but a slacking off is noticeable now, and is not likely to be overcome until after next May, when the termination of the coal trade subsidy on the present basis is due.

Locomotive builders are getting a fairly large number of orders, but the total number of orders is not enough to tax the resources of the important shops. Traction engines are in fair demand, and gasoline locomotives of 40 to 50 horsepower for use on sugar plantations in Queensland and Fiji are among recent orders of interest.

Current Editorial Comment

in the Machine-building and Kindred Industries

THE METRIC BILL AGAIN

At a recent hearing before the House Committee on Coinage, Weights and Measures, on a bill known as H. R. 10, providing for the compulsory use of the metric system, introduced by Congressman Britten, the only opponents of the bill present were Messrs. Stutz and Dale of the American Institute of Weights and Measures.

Upon several occasions in the past when metric bills were introduced in Congress, MACHINERY has voiced what is believed to be the general opinion of those responsible for the maintenance and progress of our machine-building industries —that a change in the system of weights and measures is not a question that Congress should pass on; but one that should be decided by manufacturers and engineers who are thoroughly familiar with the whole question. The system of measurements used in engineering and industrial work is so closely interwoven with our whole mechanical progress that the effect of so radical a change can be forecast only by engineers and manufacturers possessing practical experience. If it is their judgment that the change would involve so much confusion and loss, and would develop so many mechanical difficulties as to completely overshadow any possible gain, then the present system should be let alone. When our manufacturers and engineers can see that the proposed change would benefit our industries or increase our foreign trade sufficiently to warrant the resulting expense and widespread confusion that the change would entail, no law will be needed to force our manufacturers to adopt it.

* * *

SIMPLE METHODS OF SHOP COST-ACCOUNTING

The management of every manufacturing plant and machine shop, however small, must keep some account of its costs, if it is to remain in business. The shop doing contract work or the one building special machinery to new designs, requires dependable cost information as a guide in estimating the cost of new work and fair prices. Correct cost data also provide a valuable check on shop practice, and assist in meeting keen competition, both in contract shops and in manufacturing plants where duplicate machines or parts are produced on a quantity basis.

As cost estimating in all machine-building plants presents difficulties not encountered in most other lines of manufacture, a clear understanding of sound cost-accounting principles is most important. There are so many variable conditions in machine building that it is impracticable to compile cost data which can be used universally. Work can be done much cheaper in one plant than in another because better tools and methods are employed. Then, too, parts used by different manufacturers are in endless variety as to shapes, sizes, materials, quantity and accuracy required. For these reasons, costs must be based partly upon local conditions; but there are certain fundamental principles which apply in all machine-building plants, regardless of product or equipment.

This number of MACHINERY contains the first of a series of five articles in which the author deals in a practical way with the important cost-finding problem. Many valuable suggestions will be found in these articles about methods of obtaining and utilizing cost data having real economic value. These articles do not cover cost system details, such as card forms, etc., since the exact details must suit conditions in each plant; and it was considered much more important to emphasize features that are vital in all efficient cost systems. The author has placed upon record outstanding facts which his many years of experience have demonstrated to be of value to shop and plant managers. The whole idea, reduced to a few words, is to make the cost of cost accounting a profitable investment.

* * *

INSTALLING MACHINES ON TRIAL

When high-production machines embodying radically new principles are developed, the builders sometimes offer to install trial machines to substantiate what seem to be extraordinary claims. Improvements in these machines frequently are suggested after a thorough trial under regular manufacturing conditions. Such trial installations are an example of cooperation between the machine tool builder and his prospective customer, and should not be classed with trial installations of machines that are of standard and generally accepted design.

Several important buyers of machine tools have recently requested manufacturers of similar kinds of equipment to install one or more machines in their plants on trial, so as to permit a comparison of the different types of machines, but with no obligation to buy. At the end of the trial period, which may be thirty or ninety days, all the machines may be returned. Meanwhile they have been engaged on productive work, the machine tool manufacturer furnishing the equipment free of charge.

There are many strong objections to the establishment of this practice. At the end of the trial period, the machine tool builders may have to take back some second-hand machines, and are certain to incur considerable loss. The capacity of most machines can be demonstrated without placing them on trial in the customer's shop. They can be bought with sufficient guarantees, so that if they do not perform the work for which they were sold the buyers may return them. But there is no precedent in ordinary business practice for the installation of a machine to be used on productive work for one or more months, and then returned, even though it has fulfilled all reasonable expectations; and no such precedent should be established.

Several machine tool builders have refused to install standard machines on trial, and the experience of one of these manufacturers indicates that it is well worth while to have the backbone to say "no." Within a week of his refusal to comply with such a request, the prospective customer sent an engineer to his plant to examine and try out his machine. In another week an order followed, and since that time twenty machines have been sold to the same customer.

* * *

SERVICE OF THE TOOL SPECIALIST

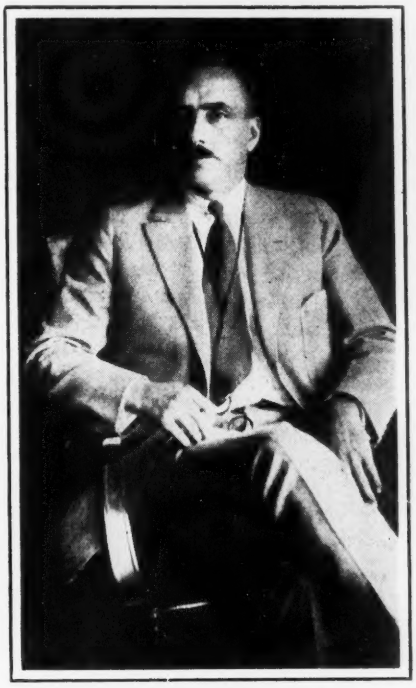
Every manufacturer who maintains a large tool designing department and an expensive tool-room of his own, should investigate his actual costs and results, as compared with those offered by shops that specialize in a product and service that with him is merely a side line. Machinery manufacturers know that they cannot afford to build their own machine tools. They have found that beyond question it pays to buy machine tools from the shops that specialize in producing them, and they should investigate to determine whether it would not pay also to have specialists make the tooling equipment required. The modern trend is toward the use of the special service rendered by such tool shops.

Creating Better Understanding in Industry*

By CARL F. DIETZ, President and General Manager, Bridgeport Brass Co., Bridgeport, Conn.

THE development of our industries has radically changed the relation between employer and employe. In the past, there was a personal relationship—the employer knew his men by their first names, and they knew him and could speak to him directly on any matters that seemed to require his attention. In the big industries of today, such a personal relationship is impossible, and new methods have to be devised to retain, as far as possible, a contact between management and employes.

In the earliest days of industrial activity, when machinery began to replace hand labor, the first effect upon the minds of the workers was to create a very definite opposition toward everything intended to increase the productivity of the individual. The workers immediately thought that if they did more today than they did yesterday, because of the assistance of a machine, some of them would shortly be out of a job. At first this idea was so strongly seated that there was a great deal of sabotage and actual smashing of machinery. The life of one of the early inventors in the textile machinery field was actually in danger because of this resentment toward machinery. In various forms it still persists, and there is an actual "fear of production" manifesting itself in various phases of human activities.



Carl F. Dietz†

Gradually, however, clear-thinking individuals are propagating the thought that, after all, greater production, in the long run, benefits everybody. If the early idea prevailing at the time the first machines were designed had persisted, the world would never have attained the standard of living that exists at present in industrial countries such as our own. It is only because of the great production made possible by machinery that so many comforts and pleasures are cheap enough to be within the reach of nearly everyone.

Machinery and Intense Production Methods have Made the Automobile Possible

I have had the opportunity of living in several foreign countries and of seeing how people in other parts of the world live. When you try to compare their standard of living and the economic status of the majority of the people in this country, you find that there is actually no basis of comparison. Some time ago I met the manager of a large foreign plant. In explaining to him some of the problems confronting the management of an American industry, I mentioned that it was necessary to provide a considerable amount of parking space for the automobiles of the employes, where the cars could be kept during working hours. He looked at me as if I were joking. He could not conceive of men who work mainly with their hands having automobiles and driving their own cars to the shop where they work. He remarked that such a thing was absolutely impossible in his country; and yet, he came from a very highly industrialized part of Europe.

Here is an example of what highly developed machinery and intensive production methods have done for the great mass of the inhabitants of the United States. In this country, there is an automobile for every six people; in England there is one for every sixty; in Germany there is one for every six hundred. Similar comparisons could be made in many other directions. There are many things that are commonplace and considered necessities in the United States that would be extreme luxuries for most people in Europe and in other parts of the world.

Our Present Industrial System Presents New Problems to be Solved

From time to time we hear opposition to our present industrial system voiced, claims being made that it is wholly based on selfishness and greed. Every thinking man admits that our present system has its faults, but he must agree that so far no one has invented anything that is better. With all its faults, our present system works; and the experience of the world during the last ten years has shown that those who have been successful in tearing down the present industrial system are not only in a much worse state today than they were before, but probably in a worse economic state than they would have been if they had never emerged from the condition in which they were before our industrial evolution began.

It is necessary, however, in order to maintain such relations of peace and cooperation between employers and employes as are essential to the growth and welfare of the community that much the same contacts be maintained between the management and the men as were maintained when the industries and shops were smaller. As stated, today it is utterly impossible for the manager of a shop to know every workman personally. For this reason, a different method of maintaining friendly relations between management and employes has had to be developed. One of these methods is the establishment of what is known as the "industrial council"—a representative body elected by the men to represent them in matters of common interest to them and to the management. Through these councils the policies of the management can be conveyed to the men. It is important that these policies be carefully and truthfully conveyed; otherwise the man at the bench may get a distorted idea of what the management is endeavoring to do and what its policies are.

Probably there is nothing more important for the maintenance of friendly relations in an industrial undertaking than a clear understanding on the part of the men of the general policies and aims of the management. If these pol-

---

*Abstract of remarks made before a shop committee meeting of the Yale & Towne Mfg. Co., Stamford, Conn.

†Carl F. Dietz was born in New York, February 12, 1880. He graduated from Stevens Institute of Technology in 1901, and subsequently took post-graduate courses in engineering, metallurgy, and mining at the Royal Technical College, Berlin, Germany. He was at first employed by the United States Steel Corporation, being engaged mainly in blast furnace operation and in the studying of blast furnace gas engine problems. In 1905 he engaged in the development of zinc-smelting processes, and later operated a mining property in Utah, installing a dry method for concentrating lead-silver ores. He designed and built ore-milling plants in the United States, Canada, Mexico, and Europe, and led explorations in the tropics of South America. He made numerous examinations of mining properties and mills here and abroad. In 1908 he joined the engineering staff of Minerals Separation, Ltd., London, whose mining and metallurgical properties required extensive travel. In 1911 he joined the Norton Co. of Worcester, Mass., as plant engineer. He was associated with this company as vice-president and general sales manager until 1921, when he became president and general manager of the Bridgeport Brass Co. Mr. Dietz is the author of numerous papers on scientific subjects, and is a member of the American Society of Mechanical Engineers, the American Institute of Mining and Metallurgical Engineers, and the Institute of Metals.

icies are not properly interpreted, misunderstandings are certain to arise. The most important duty, therefore, of a shop council, a superintendent, or a foreman is to get a clear conception of management's policy and to interpret it clearly and definitely to the men in the shop.

A more helpful and sympathetic spirit in industry is the kind of thing on which an industry will thrive and grow, rather than a dictatorial system without regard for personal feelings. Some twenty-five years ago, when the idea of efficiency studies were developed, and in many cases satisfactorily applied, the human element was frequently overlooked. It took some years to realize that, while it is possible to do anything within reason with equipment or machinery through careful time studies, if the human element were neglected, all the time studies in the world could not bring about more than a small percentage of the efficiency which was the final objective. It is only recently that management has risen to the conception that a truer relationship between management and men in any enterprise constitutes one of the main avenues to success.

Combating Erroneous and Misleading Propaganda by Accurate Information

The management of every industrial undertaking should endeavor to supply simple fundamental information to the men in the shop, giving them a correct idea of business economics. This is as important in creating friendly feelings as anything that can be done. The more the men in the shop appreciate the problems of the management, the better will be the harmony and the greater the cooperation possible in attaining the objectives for which management and men alike must be striving.

The present era is essentially one of propaganda of all kinds. Much of this propaganda contains lies and misstatements having no foundation. If these misstatements are not corrected, however, no one can blame the men engaged in industrial work for believing them. If the management has the ability to think reasonably straight, it is its duty to convey the same idea of straight thinking to the men. I believe that industry must, sooner or later, undertake to bring about a clearer understanding of the principles of production and objective of business if there is to be any chance for harmony and cooperation in industry.

I have heard a soap box orator say that if he was paid a dollar for the work on an article and it was sold for $10, the firm made a profit of $9. Only accurate information can combat the effects of this kind of economics. If the men listening to this orator had been given information as to what taxes were being paid, what the cost of power was in the plant, what it costs to have the whole plant shut down for half an hour, what the interest on the equipment amounted to, the cost of administration, selling and advertising, etc., they would have recognized at once that the soap box orator was either dishonest or ignorant of actual conditions. But remember, if the men in the shop know nothing about these expenses, it is not their fault, but the fault of the management which has made no effort to inform them.

What it Costs to Employ a Man

How many men in the shop know that for each man that is hired and put to work, somebody has had to provide approximately $5000 for the erection of buildings and the buying of machinery and equipment. The statistics of the United States Census of Manufactures show that approximately that amount is required in the industries of the United States as an initial investment for every man employed in industry. In some industries, of course, this amount is somewhat less; in some, notably in the metal-working industries, it is slightly more. Somebody has had to supply that amount from his past profits, earnings, or savings. Would it be reasonable to expect that he would do so without receiving some return for the capital invested? If he received no return, might he not as well spend his money for pleasure and travel, for example, rather than put up a brick building and buy machinery?

The Right Attitude in Creating Friendly Industrial Relations

A friendly attitude and the furnishing of accurate information will do more to create a cooperative spirit in industry than anything else. I commend to every individual in every industrial establishment that he make an energetic effort to develop the human side of his relations with his fellow workers, whether it be between men of the same status, or between men who work mainly with their hands, and the foreman, superintendent, or manager.

Personal sympathy and understanding and correct information about the business will bring about infinitely better results than can be obtained in any other way. When men come to work in the morning and return home at night with a friendly feeling toward the plant in which they work, you have a group of individuals working together, everyone doing his best toward promoting the success of the whole undertaking. Such an attitude on the part of the men can be created only if they are treated in a friendly manner by those in authority, and such treatment includes the willingness to supply them freely with information relating to the policies and aims of the business and its general status, so that they will feel as if they are a real part of the business.

* * *

THE REFRIGERATED LABORATORY

In a paper presented by D. M. Pierson before the annual meeting of the Society of Automotive Engineers at Detroit on the "Dodge Brothers Refrigerated Laboratory," it was pointed out that the question of successful and satisfactory performance of automobiles at low temperatures has in recent years assumed greater importance than ever before. More people are using automobiles throughout the year than in the past, and hence it has become necessary for the automobile manufacturer to study the performance of automobile engines and other equipment at low temperatures. To do so, it has become necessary to equip laboratories in which a low temperature can be maintained. At the Dodge Brothers plant such a laboratory has been installed, in which a low temperature is maintained while the car is operating with a power development equivalent to the road load at speeds up to 35 miles per hour. In many sections of the country, successful automobile performance is expected at temperatures as low as 20 degrees F. below zero.

This laboratory is built as a separate room in one of the assembly buildings. It consists of a refrigerated room heavily insulated, provided with an electric absorption dynamometer of the cradle type, an ammonia compressor, and other necessary equipment. The inside dimensions of the cold room are 11 feet 6 inches in width, by 32 feet in length, by 14 feet in height. The actual available laboratory space is, of course, considerably smaller, because part of the room is taken up by cooling coils and an air circulating fan. The walls are made of "Crescent" cork board as furnished by the United Cork Co. The walls are 8 inches thick at all points. For ease of handling, the material for the walls was obtained in the form of bricks, approximately 20 by 30 by 4 inches, a binder of asphalt being used in the construction.

In order to maintain a temperature of 20 degrees F. below zero, in the room with an engine developing 10 brake-horsepower at a speed equivalent to 35 miles per hour, it was necessary to absorb 210,000 British thermal units per hour. The temperature can be lowered from 70 degrees F. to —20 degrees F. in four hours. As yet, the lowest possible temperature that can be obtained has not been definitely ascertained, but a temperature within the expansion coils of 64 degrees F. below zero has been reached.

It is of interest to note that the temperatures obtained are too low for the use of mercury as a recorder of the temperature. A mercury well had been installed in the suction line from the expansion coils just ahead of the compressor, in order to study the temperatures prevailing in the coils. During one of the tests, the mercury in the well was found to be frozen solid, so that no readings could be taken, the freezing temperature of mercury being —39 degrees F.

The Problem of Used Machine Tools

By a Machine Tool Sales Manager

THE machine tool industry has many problems to solve. With few exceptions, machine tool builders are not operating, even in this period of comparatively good business, on a basis of profit that will allow them to pass through a period of less activity without difficulty. In this connection, the conditions created by the presence of used machinery on the market cannot be ignored.

Among machine tool builders we hear on every hand reference made to the ever-present problem of used machines. Quite often, in conversation with other machine tool builders, I have heard the second-hand machine problem referred to as more or less of a temporary condition which we must endure for a few years but which we can hope will subside. Such is not the case at all. The problem of used machinery and second-hand machine tools will be always with us. Prior to 1914 we had second-hand machinery competition to combat. It is true we had a greater market for new machine tools, as compared with our manufacturing capacity, than we have at present, and consequently the competition from used machines was not so keenly felt.

Immediately following the war a situation developed due to the great number of government surplus machines and munition plant equipment dumped on the market, with which the machine tool builder, with his limited resources, could not hope to cope. Time, however, has eliminated the greater portion of this surplus of used machines from the market, and it may be said that the situation has now simmered down to where we have and can expect to have a certain varying amount of second-hand machinery constantly on the market. This is the problem that we believe the machine tool builder must eventually take in hand and endeavor to control. Some machine tool builders have already begun to operate used machinery departments on their own account, embracing the purchase, reconditioning, and resale of used machines originally built in their own plant.

Advantages of a Used Machinery Department

The machine tool manufacturer may acquire possession of his own used machines by buying them in the open market, by taking them in trade when selling new machine tools, or by buying them at auction or from plants that are liquidated and going out of business. Several objectives may be accomplished in such an operation.

First, by buying such machine tools as appear in used machinery dealers' lists or as may be occasionally offered as surplus by production plants, the machine tool manufacturer at once removes from the market a serious element of competition to the sale of his own new machines, and at the same time makes it possible to supply some of his customers with used machines that he has had an opportunity to overhaul. He thereby increases the degree of confidence with which his products will continue to be used by the trade.

Second, the machine tool builder, by careful management, may purchase at the prevailing used machine price, and by rebuilding, put the machines in such a condition that they may be sold at a price well below the new price list and still afford a profit. Under all circumstances, the machine tool builder is warranted in taking this profit on the sale of his used machines if he is to be called upon to "service" the used machine and to back up its performance. Such is often the case, whether the used machine is purchased from the original builder or from some used machinery dealer.

Third, with some machine tool builders nothing has been so destructive of price maintenance as to meet in competition a large number of his own machines, offered in fairly good condition at ruinously low prices. The only possible method by which the machine tool builder can assume control of this drag on the selling price is to control, to a certain extent, the sale of used machines.

How to Operate a Used Machinery Department

Some precautions must be carefully observed by the machine tool builder who wishes to enter the used machine market. These precautions, over long years of experience, have become fixed rules of operation for the machinery dealer who is successful.

First, the machine tool builder must learn to buy his own machines at the right price—at a price that will enable him to lay them down at his factory, add the necessary material and hours of work to make them acceptable to his customers and satisfactory in operation, and still maintain a margin of profit, be it ever so small.

Second, in setting allowances to be used in trade deals, the machine tool builder must observe the same precaution as is exercised in the purchase of a used machine at auction. The used machine department should be made to show a profit at all times. Extravagant allowances in trade, which are made merely to effect new machine sales, but which eventually reflect a loss in the operation of the used machinery department, is only another way of cutting prices. It is not necessary for the machine tool builder to show a high profit in the operation of his used machinery department, but he should conscientiously avoid the operation of the used machine business at a loss.

Third, careful selection and the combined judgment of the shop and the sales department must determine what work is to be done on the used machines—whether they are to be entirely rebuilt and sold as guaranteed machines; whether they are to have only the work done that is absolutely necessary to their proper operation and sold as reconditioned machines; or whether they are to be disposed of "as is" for definite operations which can be done on old and inaccurate machines.

Organizing the Sales of Used Machines

The selling price of used machines, sold in whatever condition, must be determined by the purchase price, transportation and handling costs to the factory, plus material, labor, and full overhead, as regularly charged to the construction of new machines. On top of this should be added a sufficient profit.

The sale of used machinery may be handled in one of three ways—direct through the manufacturer's own sales department; through dealers; or by a combination of both. When sales are handled directly through the manufacturer's own organization, it is possible to keep the salesmen in very close contact with the trade. Prospective customers can be approached, and in cases where it is not possible to interest the customer in new machines, his attention can be switched to a used machine which can be offered at a price within the means of the customer and which at the same time will handle the particular work in a satisfactory manner. In this connection, it must be borne in mind that the salesman has three types of machines to offer—a rebuilt machine backed by a factory guarantee for new-machine accuracy; a good used machine whose condition, after minor adjustments have been made, warrants its being offered to the customer with a guarantee of satisfactory performance; or a used machine sold "as is" and backed by the manufacturer's guarantee to perform satisfactorily on the job in question.

In case the manufacturer is without a direct selling organization, the dealer can be furnished with a complete list

of the used machinery available for resale. This list can be prepared so as to give descriptions, in the most minute detail, of the condition and equipment of the used machinery being offered.

There is a growing tendency on the part of machinery dealers to enter into the used machinery field, even though their sales efforts are still concentrated on selling new machines. This policy is becoming more general because of the fact that there are so many used machinery dealers who are continually offering competition in the sale of new machinery. When such cases arise, there is no question but that the dealer, in offering a used machine, prefers to offer a machine that he knows is in a satisfactory working condition and that will be backed by the guarantee of the manufacturer. He is not only protecting himself, but is protecting his customer as well.

* * *

SEVEN YEARS IN THE MACHINE TOOL INDUSTRY

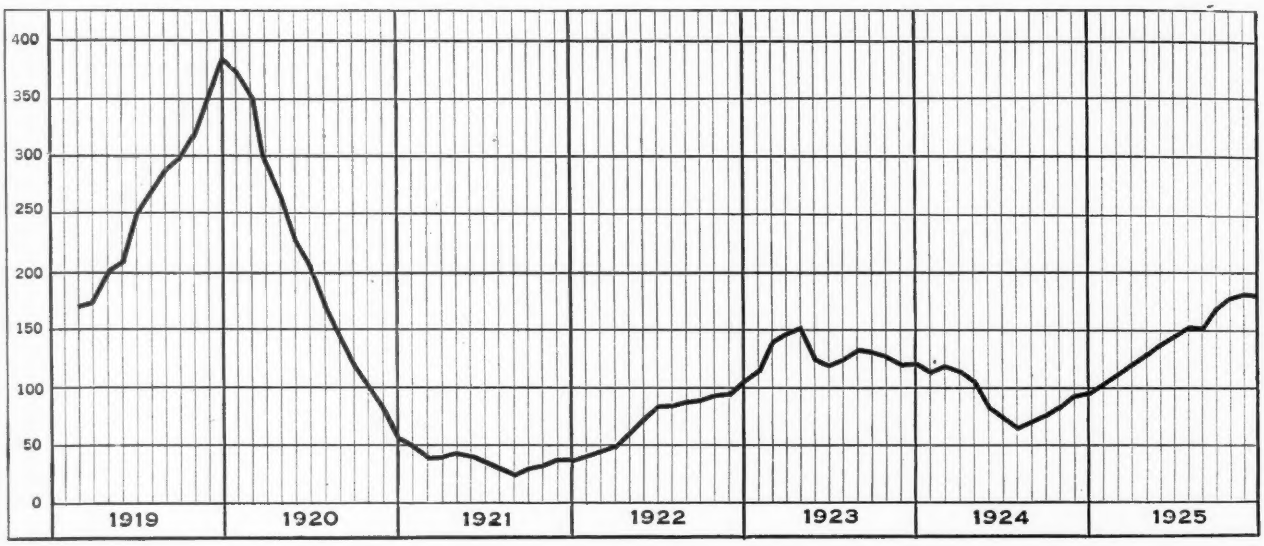
More and more, executives are basing their future business plans on a careful study of the various indexes of business conditions that are now available. A few years ago these indicators of business conditions were not available, and an executive had to make his plans largely by intuition and guesswork. Now the trend of business is being charted by many different institutions and trade associations. This makes for greater stabilization in industry, and in the long run is of benefit to everybody engaged in business. In the machine tool industry, the fluctuations are unusually great, and hence, a curve of the business in this industry shows a marked tendency at all times.

The accompanying illustration shows the record of the machine tool industry from 1919 to 1925, inclusive, as compiled from the experience of sixty manufacturers reporting to the National Machine Tool Builders' Association. The base line of the chart, or the 100 per cent line, is constructed on the basis of the monthly average shipments for the years 1922, 1923, and 1924. Then each month's total orders, as a percentage of this basic figure, give a monthly percentage index. In order to smooth out the curve and to obtain the trend more definitely, these figures were reduced to what is known as a "three months' moving average," so that the curve begins, as shown, with the average of the first three months of 1919, plotted on the March date line for that year. The curve is a reliable index of the machine tool demand for the last seven years.

If the machine tool index as shown in the illustration is compared with a curve indicating the fluctuations in general business, it will be noted that machine tool demand picks up more slowly than business in general. But a depression in the machine tool industry starts sooner than in other fields; hence, the machine tool builder gets practically no economic signals from other industries to warn him of a coming slump. The only signal he can get is the index of orders in his own industry taken as a whole.

The chart also shows that the machine tool industry is much more fluctuating than practically any other industry, and hence, much more difficult to operate. It means that this industry cannot be operated altogether on the same economic principles as other manufacturing fields. There must be some kind of reserve to carry over the years when the curve falls far below the normal base line. This is true not only of the machine tool industry, but of equipment industries in general, as has been pointed out by Professor John Morris Clark of the University of Chicago, who emphasizes that these industries must give much more consideration to economic factors than industries in which the fluctuations are less violent.

Every equipment industry ought to collect and publish similar information to that produced by the National Machine Tool Builders' Association, because all machinery builders suffer from similar fluctuations in their industries. By cooperation in the compiling and studying of data in different fields, the various equipment industries would be able to help each other to obtain a true picture of the business situation, and they would also be able to educate their customers to distribute their orders over a period of time, to the benefit of both the customer and the manufacturer. Charts of this kind also indicate the modern trend in business management, whereby definite knowledge is substituted for the opinions and guesses of the past.



Index Curve of Machine Tool Orders, 1919 to 1925—Average Monthly Shipments 1922 to 1924, Inclusive, are considered Equal to 100 Per Cent

* * *

RESEARCH FELLOWSHIPS OF LEHIGH UNIVERSITY

The Institute of Research, Lehigh University, Bethlehem, Pa., announces that on June 1 this year three fellows will be appointed. One of the fellowships is for two academic years beginning September 1, 1926, with an annual stipend of $600. Half of the time of the holder of this fellowship must be devoted to research work in the field of science or technology to which he is assigned, the other half to graduate study leading to a degree of Master of Science. Two other research fellows in engineering for a period of two academic years, with an annual stipend of $750, will also be appointed. Half of the time of the holders of these fellowships must be devoted to research work on some problem in electrical, mechanical, or hydraulic engineering as approved by the Institute of Research, and the other half to graduate study leading to the degree of Master of Science. Further information relating to these fellowships may be obtained by addressing Charles Russ Richards, president of Lehigh University, Bethlehem, Pa.

Applying Group Bonus in Tool-rooms*

By JOSEPH LANNEN, Paige-Detroit Motor Car Co., Detroit, Mich.

ONE of the principal aids toward cost reduction in manufacturing has been the application of wage incentives in the form of piece-work, individual bonus, and group bonus. In the present article, the methods used by the Paige-Detroit Motor Car Co., for measuring and applying wage incentives in the tool-room, maintenance, and machine repair departments, will be described.

Briefly, the method followed in applying a group bonus system in these departments is as follows: For every job a separate order is issued, and an estimate is made of the time that should be required for the work. A copy of the estimate and order is forwarded to the time department, and the order is forwarded to the department in which the work is to be done. The time required by the men for completing each job is kept, and at the end of each pay period, the actual time required and the estimated time for all jobs completed during that period are compared. If the actual time is less than the estimated time, the equivalent of the difference, in dollars and cents is pro-rated among the men in the group, the share of each man being based upon his earnings during the pay period. If, on the other hand, the time taken to do the work is greater than the estimated time, then the men are paid their regular day rate.

Is it Practicable to Apply a Bonus Incentive to Tool-room Work?

This type of incentive was first applied to the tool-room. It is not practicable to make time studies of tool-room work in the same way as is possible in production work, and at first thought, it might seem impossible to estimate accurately the time required for tool-room work. Experience has shown, however, that this can be done effectively.

For several years, the cost of tools has been estimated before the tools were made, and it has been found possible to obtain tool estimators who can estimate the costs well within 10 per cent of the estimates made by outside tool shops for the same work. It is evident that any tool shop that takes tool work on a contract basis must have someone capable of making a cost estimate in advance, and while it is almost impossible to establish standards for this class of work, a man can acquire sufficient experience to estimate the cost of tools with a very high degree of accuracy.

How the Bonus Plan was Inaugurated

Having found it possible to successfully check the estimates on tools ordered from outside shops, it was only natural that the same methods should be applied for estimating the cost of tools to be made in the company's own tool-room, and the next step was to use this estimate as a basis for the development of a wage incentive or bonus plan for the tool-room. This idea was carried out in the following manner:

The desk of the estimator was moved into the tool-room and he estimated every job coming into the department. Difficulty was anticipated in estimating repair work, but the problem was solved by estimating the cost of disassembling the jig or fixture to be repaired and, after the extent of the repairs required was determined, estimating the amount of work necessary to put it into good condition. In order to keep an accurate record of the time applied to each job, it was necessary to install a clerk to keep the time and issue job tickets. This clerk also keeps a record of the time applied to each job.

One month after the estimator moved into the tool-room, the bonus system was put into effect. This was in May, 1924, and it has been in effect ever since. The average bonus earning during this period has been 6 per cent of the wage paid. The maximum received in any one pay period was 27 per cent. Bonus was not earned during eight pay periods.

Advantages Gained by Tool-room Bonus System

Besides being able to reduce the cost of tools, the following results have been attained: It is possible to predetermine the cost of building tools. The estimate enables the tool-room foreman to schedule his work and give accurate promises as to when a job will be completed. It is possible to estimate the maximum number of toolmakers that can be employed without installing additional equipment; as lost time due to men waiting for machines affects the bonus, the men lose no time in calling this condition to the attention of the foreman.

The bonus plan promotes cooperation among the toolmakers. As an example, an alteration to a conveyor made it necessary to mill, drill, and tap 150 hooks. While one hook was being milled, the operator drilled one, and a lathe hand, roughing a large piece of stock on another job, used his spare time between cuts to tap hooks for the man who was milling and drilling.

The group principle has the same effect that it has on production work; the men check up on each other and complain of slow work. This has had the effect of increasing the wages paid in the department. It is customary for automotive shop tool-rooms to pay a lower wage than the commercial tool shop, where work is not so steady. The result is that the men constantly feel that if they were working in a jobbing shop they would make more money, and the best men go to the jobbing shop. This causes the foreman in the automobile shop tool-room to feel that if he demands the same output as the jobbing shop, he must pay the same wages, or the men will go where they can get jobbing shop wages.

After the tool-room bonus was installed, there was a natural sifting out of those who could not or would not "make bonus," and when the employment department attempted to replace them at the established rate they found it impossible, and were forced into increasing the rate until the rate plus bonus equaled the average jobbing shop rate. Another advantage of this system is that the men try to complete as many jobs as possible before the end of each pay period, so that they can collect the bonus on them.

Group Bonus Plan in the Maintenance Department

After this form of wage incentive had been in successful operation for several months, it was decided to attempt to inaugurate it in the maintenance division. This was obviously a more difficult problem than that presented in applying it to the tool-room and required different means of application. The maintenance division is made up of the following crafts: Millwrights, carpenters, electricians, pipe fitters, painters, machine repairmen, belt men, and oilers; the work is of two general types—construction and maintenance.

For group bonus payment purposes, the department was divided into the two general groups—construction and maintenance. All construction work was estimated by the supervisor of maintenance, and the form of bonus previously described applied to it. Work of a maintenance nature was given a bonus based on the number of cars built. The gains and losses accruing from these two forms of incentive were then added together, and the resulting gain, if any, was divided among all the employes of the maintenance division.

This method was not successful, due to fluctuation in the number of cars built and the fact that the maintenance

*Abstract of a paper read before the annual meeting of the Society of Automotive Engineers held in Detroit, Mich., January 26 to 29.

work did not vary in accordance with the car production. It was found, however, that the time used on construction jobs averaged well with the estimated time allowed on these jobs. Using this fact as a basis for further development, it was decided to discontinue the maintenance bonus based on car production, and attempt by degrees to cover all work as far as possible by estimates.

The timekeeping methods described in the case of the toolroom were already in use, but required further development to handle the added volume of work. It was apparent that it would be impossible for one man to estimate this work, on account of its volume and because a considerable portion of it always is emergency work; if it was to be estimated at all, an estimator had to be available at all times. Two men were added to this staff. These men, while not skilled in any of the crafts comprising the maintenance division, had a knowledge of general shop work and were capable of making the plans and sketches necessary to determine how a job should be done. They had no previous experience in estimating this type of work, but in a remarkably short time, with the assistance of the supervisor of maintenance, they were able to give estimates that averaged well when totaled for a pay period. At present all the maintenance work is covered by a group bonus plan, with the exception of the work of two belt men, two oilers, two electricians, two steamfitters and four yard men who are continuously repairing railroad tracks.

How Machine Repair Work is Handled

It was found necessary to separate the machine repairmen from the regular maintenance group and provide a separate bonus for this department. Their work is estimated by the foreman. Permitting the foreman to make his own estimates while a departure from the general principle employed in estimating this class of work, has some advantages that may overcome its obvious disadvantages. It forces the foreman to give his men an allotted time in which to do their work, and places in his hands the means of rewarding his men for good performance.

During the four months that the maintenance department bonus plan has been in operation, the maintenance division, which consists of seventy-four men, has earned an average bonus of 10 per cent of their wages. The maximum bonus received in any pay period was 14 per cent, and the minimum was 7 per cent. The machine repair department has averaged 12 per cent, with a maximum of 20 per cent and a minimum of 9 per cent.

The successful development of this form of wage payment had many advantages. It provides the foreman with a means of checking the efficiency of his men. It also provides the management with a means of checking the efficiency of the foreman, and, last but not least, it enables the supervisor of these activities to show the management for what money is going to be spent. The management, in turn, feels that it has control of what in the past was more or less of a guess.

Measuring this type of work and applying a bonus incentive has to the author's knowledge, never before been attempted, and though the methods are comparatively new and untried, he feels that the results obtained justify passing them on to those who may wish to apply and develop the system to a greater state of perfection.

* * *

There was a considerable decrease in the tonnage of the world's shipbuilding in 1925, as compared with the previous year, and it is of interest to note that the tonnage launched was less than in any year from 1900 to 1907, with the exception of 1903 and 1904. From 1911 to 1914, inclusive, and from 1917 to 1922, inclusive, the tonnage was much larger than in 1925. Of the total tonnage launched in the latter year, Great Britain is responsible for about 50 per cent, Germany coming next in order with nearly 20 per cent. Shipbuilding in the United States, counting both coastwise and Great Lakes shipping, fell to about 6 per cent of the world's total. In 1920 it was about 40 per cent.

THE FIRE HAZARD IN MACHINE TOOL PLANTS—ARE YOU PROPERLY INSURED?

By ERNEST F. DuBRUL
General Manager, National Machine Tool Builders' Association

Recently, a machine tool plant employing about 100 men was completely destroyed by fire. The building was one-story, brick, with a wooden roof. As the floors were oil-soaked after many years of use, the fire spread so rapidly that all the efforts of a very efficient fire department could not save the building. There was no sprinkler protection. It is problematical as to how much of the contents of the building will be usable after the debris is cleared away. The burning roof fell in on the contents. This fire occurred during weather far below freezing, and the heat was followed by drenching with very cold water. It would not be surprising to find that there is very little, if any, salvage of contents suitable for further use in a machine tool plant.

This fire has a number of lessons in it for the industry. The first lesson is that every plant should have sprinkler protection. The second is the danger of wooden buildings, in which great loss can be caused to contents by a blazing roof falling in. Even a steel trussed roof with exposed wooden sheathing is dangerous. Wooden sheathing can be and should be protected on the inside by some fire-resisting material.

Another lesson of this fire is that insurance should be carefully scrutinized, and should be kept up to the amount necessary to replace buildings and contents. This plant was insured for an amount that appears to be far less than needed to replace the equipment and goods in process. If insurance is not carried up to true value, then the owners stand a risk that is not figured into the cost of production. If this risk is fully covered by insurance, the premiums must be paid in cash, the bookkeepers will enter them, and the cost of the risk will appear on the cost sheets.

Still another lesson to be learned from this fire is that every machine tool plant should carry "Use and Occupancy" insurance, which covers the loss of profit and overhead during the time required to get the business going again. Even though patterns and drawings are saved, and even though another well-equipped shop could be found immediately in which to start business, there would be some delay in making the jigs and fixtures necessary for accurate production, and in getting production under way. "Use and Occupancy" insurance covers loss of profit and cost of overhead for the time required to get back on a production schedule. "Use and Occupancy" is a risk attached to any business, and if insurance be taken against this risk, the bookkeeper is sure to charge the cost of carrying that risk against the cost of the product. Without insurance, that concealed cost does not go on the cost sheets, and is not likely to be represented in the price of the product. Should the machine tool builder find that he cannot afford to pay for full coverage of all these risks, this demonstrates that his profit margin is too low, and that he is carrying risks that should be compensated for in the price of his product.

The best insurance, of course, comes from installing a machine tool business in a fireproof plant. If the business cannot afford such a plant, the owners are taking a greater risk than is justified by their margin of profit. Machine tool users can and should pay for at least all the insurable risks involved in producing the tools they buy.

* * *

CONVENTION OF MANAGEMENT ASSOCIATION

At the convention of the American Management Association to be held at the Hotel Astor, New York City, March 3 to 5, separate group meetings will be held for financial and office executives, for production and operating executives, and for sales executives. Papers will be read on a great number of subjects of interest to those actively engaged in the management of industrial undertakings. W. J. Donald, 20 Vesey St., New York City, is managing director of the association.

The Foreman's Place in an Organization

By J. SETON GRAY, Industrial Engineer, A. O. Smith Corporation, Milwaukee, Wis.

THE success of any factory depends largely on the foremen and sub-foremen, and the understanding they have of their job. A foreman is not only the leader of the men in his department, but he represents the management to his men. It is his duty to look after his employer's interest, and at the same time see that the men under him get a square deal. He has been chosen from the ranks on account of his superior knowledge and skill, and placed in charge of certain work. He should realize what authority goes with his job, and should see that everyone with whom he is associated knows and respects that authority. He represents his employer at all times, even after he has left the factory for the day; and if he is not willing to do this, he should not accept such a position.

The Foreman's Position in the Business

A foreman is really in business for himself. He receives material, either in the raw or semi-finished state, and completes the operations necessary in his department, sending out a complete, or semi-complete, article. His department must earn a profit, just as the whole factory must earn a profit in order to remain in business. Every foreman must see that his department earns dividends. He has the same problems to face as are faced by the general manager of the whole factory, only on a smaller scale. He must look on his job in the same way as the general manager looks on his. He has been trusted with the expenditure of money, represented by the investment in machinery, equipment, buildings, raw material, and wages. Is he spending this money in the same way as the general manager would if he were in that situation and had to meet the same problems? Is he dealing with the men in the department as if he were their actual employer?

A department that is supervised properly will run itself. The right kind of supervision starts with the management and is passed on down the line until the foreman is reached. The foreman who is busy running around all day long usually accomplishes very little. He is a poor executive and the best results are not obtained in his department. A foreman should never be so busy that any one of the men cannot come to him for advice at any time of the day. He should not need to say, "I am too busy right now; I will see you later." He should have the time.

The Responsibilities of a Foreman

The excuse has been offered by many foremen when they fail on a job that they did not know just what they were responsible for. Part of this blame really belongs to the management, but a foreman has no excuse for not knowing the extent of his duties. The first thing he must do is to analyze his job, and be sure that he knows the full extent of his activities, what he is responsible for, and what his superiors view as his job. Then he must see that everyone respects the duties that come under his jurisdiction.

If a foreman will analyze his job, and take time to write out his duties on paper, so that he can look them over and check them with the work he is actually performing, he probably will find that there is work he is doing that belongs to somebody else, and that work that belongs to his department is being neglected. "Know your job" is the first step in becoming an efficient foreman.

The Foreman must be Able to Plan

Where the planning department leaves off, the foreman's job starts. He must see that his work is planned so that every man and every machine is busy at all times. It is impossible for a planning department to plan and foresee every detail, but a wide-awake foreman can see where machines are to be idle and can supplement the work of the planning department so that expensive machines are kept running to capacity.

He must see that all tools and equipment are maintained in the best possible shape, and that this is done with a minimum of interference with production. It is his job to arrange his work and to cooperate with the repair boss so that repairs will be handled with the least possible delay and with a minimum amount of over-time.

Lack of planning ability on the part of a foreman always brings about dissatisfaction among the men. No man cares to see his efforts come to naught, even if someone else is paying for it. All men like to feel that there is some real constructive value in the work they are performing. If the men lose faith in the ability of their foreman to plan the work, the department cannot be successful.

The foreman should know before he leaves the factory at night what every machine will be working on the following day. He should also know what each man will be doing, and should be sure that the necessary material is on hand, so that the work will flow smoothly and easily from the time the starting whistle blows. Not only should the foreman know this, but every man in the department should know what his work will be the following day. Probably more lost time is due to a poor start than to any other reason.

A Foreman must have an Open Mind for New Ideas

The best efficiency expert in a department should be the foreman; and he will be, provided he understands a foreman's duties properly. To this end, however, he must be shown how the application of new ideas will gradually improve conditions in his department. On the other hand, he often knows better than anybody else what will benefit his department, but due to his inability to put his ideas into words, little consideration is given to his recommendations. Efficiency experts obtain a great many of their ideas from the foremen, and, presenting them in understandable form to the management, get the credit and quicker results. If half the consideration were given to the suggestions and recommendations of foremen that is given to the recommendations of "experts," there would not be so many factories where the services of an expert would be necessary.

Methods of Supervising the Work

A department that is supervised properly will run itself. The right kind of supervision starts with the management and goes right down the line to the foreman. You will usually find that the foreman who is busy running around all day long accomplishes very little. When he is stopped by a man in the shop who wants advice, this man is often told, "I am too busy right now; I'll see you later." A foreman must never be so busy that any one of the men cannot talk to him at any time of the day. Generally, a foreman who is busy all the time is a poor executive, and the best results are not obtained in his department.

This brings to my mind a foreman known as Al, who appeared to be so lazy that he seldom, if ever, moved around. Al had his office, consisting of an old desk and a three-legged stool, on the top of a platform 18 inches high. From this vantage point, he could observe any man in his department

and see what he was doing. There was generally a far-away look in his eyes. The conversation between Al and his boss used to run as follows: "Good morning Al." "Good morning, boss." "How's everything Al?" "Fine, boss." "Have you got anything on your mind?" "Not a thing."

Finally the boss said to him one day: "Why don't you move around, Al, and take a little interest in your work instead of sitting here half asleep?" These remarks brought forth this answer, characteristic of the man: "From where I sit I can see every man in my department. At the beginning of the day I see that every man has enough work ahead to carry him through until quitting time. I let my eye wander from man to man, pausing long enough to see what he is doing. I know everything that is going on in my department, and if at any time you come through this department and find me racing around, looking at blueprints and running all over the place, that is the time this department needs watching. But when you see me sitting here looking as if I were half asleep, you will know everything in this department is in good shape."

This foreman really was an ideal man to supervise work; he did his share by seeing that his men were properly instructed, and then he left them to do their share of the job.

A foreman must be a good observer and be able to tell at a glance when things are wrong. It is not necessary for him to be on the job every minute of the day, but having observed the job earlier in the day, he should know how far it ought to have proceeded by the time he again looks at it, which may be several hours later. He must look after all the workers in his department, and see that they are not exposed to injury, that none of them are exerting themselves beyond their capacity, that tools and equipment are well maintained, and that there is no "soldiering." He should have a fairly good idea of the time required to perform the work in his department, and be able to check by observation whether the work is being done properly or not.

It may be necessary to discharge a man in order to maintain discipline, but this should be the last resort, after everything else has failed. Every time that a man quits or is discharged, someone else must be hired to take his place, and it takes time and money to train a new man to a point where he is as valuable to the company as the old man. Anybody can fire a man—that is the easiest thing in the world to do; but a good foreman is a man who can maintain discipline and order without having to resort to that extreme measure.

Knowledge of Costs and Cost Records

A foreman must have a knowledge of records, and be able to tell exactly what his department will be able to do when called on—not *think* that he can do so and so, but *know* that he can do it from past experience. He should know the capacity of the equipment in his department, and the production per man-hour on certain classes of work. The record department keeps certain records for its own use, but the foreman who wishes to run his department intelligently must keep certain records for himself and be able to prove his statement by the use of these records if called on to do so.

A foreman should know and understand costs, and all things that go toward the making up of costs in his department. He should realize that labor turnover means increased costs, that idle equipment means waste of factory space, and that as the running time of his equipment is increased, the cost of his product is automatically decreased. He should have some way of measuring results in his department and be able to show how certain steps taken by him have reduced costs. The production per man-hour and the total cost of his product should be known. He should have information covering cost of tools, supplies, accidents, material, labor, etc., and he should be able to show how these costs tie up with the production of his department.

The president of any company would never think of running that company without knowing how the total cost of the product was arrived at, and also the selling price. A foreman of a department is really a president on a reduced scale. How can he run his department intelligently if he does not know what the various charges are in that department?

In many factories very little effort is made to let the foreman administer his department intelligently, by furnishing him with this information. The result is that the foremen, not knowing what they are responsible for, pay very little attention to actual costs. This matter is looked after by someone else, who in many cases does not know the actual conditions in the various departments. Many a foreman feels that his job is to take the product from one department, perform certain operations on it, and pass it on to the next department as quickly as possible. If he can keep his department cleaned up, he considers he is taking care of his job. But he may rush all the work in his department through in six hour's time, keeping the men idle the balance of the day, waiting for the next rush of business. It may be that the same effort could have been spread out over the whole day with less men, and that there would have been a cut in the labor cost by so doing. He may not understand this phase of his job, as it never has been explained to him, and as nobody checks him up, why should he worry about it? Especially, when the general superintendent says that he is good because he is ready for the next rush of business.

Motion and time study work does not belong to the time-study department only, but should be known and appreciated by every foreman. He should know what is required for each job, and be able to check up his men without the use of a stop-watch. No matter how crude his methods may be, such study will enable him to find ways and means of eliminating unnecessary effort, and consequently cutting costs.

The Foreman as a Teacher

Instructing is part of a foreman's duties. New jobs that have not been handled before may come to the department. It is for the foreman to devise ways and means to handle this new work, and then instruct his men so that the necessary operations can be performed with a minimum amount of effort. He must see that new men are thoroughly instructed, so that waste, scrap, damage to tools, etc., are kept within low limits.

The foreman must know how to pick men for the jobs in his department, and having picked and trained them, he must know how to keep them satisfied. You will often hear a foreman say, "That man knew nothing when I took him, and now that I have taught him to make something of himself, he has gone and left me." This foreman overlooks the fact that the man had ability to begin with, and all that he needed was the opportunity. Everyone has the privilege of selling his labor in the market where the best returns can be had, and if a foreman cannot hold his men, it is a weakness on his part. The success of any foreman depends largely on his ability to keep his men.

The Foreman Must Maintain Discipline

Discipline must be maintained in every factory, and it is the foreman's duty to maintain it in his own department. There are certain rules that govern the factory as a whole. The foreman must know these rules and see that they are respected and enforced. It may be necessary to discharge a man in order to maintain discipline, but this should be the last resort, after everything else has failed. Every time that a man quits, or is discharged, someone must be hired to take his place, and it takes time and money to train this new man to the point where he is as valuable to the company as the old man. Anybody can fire a man. That is the easiest thing to do, but a good foreman is a man that can so correct someone who has done wrong that he will go back to the job with the determination to merit the approval of his foreman.

When it has been necessary to discipline a man and the man has expressed dissatisfaction at the manner in which he has been treated, take him aside and ask him what he would

do if he were the boss. He has been looking at the problem from his own point of view; when he is compelled to look at it from the other standpoint, things look entirely different. In many cases, he would be more severe than the boss himself has been. When it is necessary to speak firmly to anyone, be sure that he alone gets the benefit of it. A man does not resent a deserved "calling down," but he does resent other men hearing it.

Fairness toward the Men is a Necessity of Successful Foremanship

To have the reputation of being fair is what every foreman should strive for. There are always jobs in a department that are considered desirable. The fair-minded foreman will see that the good as well as the hard jobs are handed around, so that all feel they are being treated in the same way. A foreman who has the reputation of being fair can get more and better work from his men than one who has the reputation of playing favorites. A foreman must keep his word, and must see that his men get a square deal. This will eliminate fear on the part of the men, and will allow them to devote their brains and energy to the work on hand.

A foreman must be sincere. A foreman working at a coke oven plant during the hot summer months had great difficulty in keeping his men. Finally the management placed another man in charge. This man told the new men when they started to work: "This job is no child's play; it is hot and dirty; you will feel all tired out at the end of the first day, and probably at the end of the first week. But after that, you will find it no more difficult than any other job. You are being paid big money for this job, more than you could get for similar work elsewhere, because the work is hard. Now, go to work and I think you will find conditions exactly as I have told you." This man was sincere, and the men found that he had told them the truth. The labor turnover in that particular department was practically eliminated.

No foreman can ever hope to be successful if he does not trust his men, is continually checking up on them, and acts as if he is afraid all the time that something is going wrong. A good foreman knows whom he can trust, and lets those men carry part of the burden. A man can accomplish only a certain amount alone, but if he has the ability to so inspire his subordinates that they will act as he would under similar circumstances, he has multiplied his own ability many times and has taken a long step toward being a successful foreman and a real executive.

No foreman can ever hope to be successful if he does not trust his men, is continually checking up on them, and acts as if he were afraid all the time that something was going wrong. The good foreman learns in time whom he can trust, and lets these men carry part of the burden. A man can accomplish only a certain amount alone, but if he has the ability to so inspire his subordinates that they will act as he would under similar circumstances, then he has multiplied his own ability many times, and has taken a long step toward being a successful foreman.

A Friendly Attitude is a Great Asset

Under no circumstances must a foreman ever lose his temper, no matter how great the emergency. A man who cannot control his temper is always at a disadvantage as compared wtih another man who keeps cool and thinks clearly. In an emergency, the men look to their leader for guidance, and if the leader has lost his head, chaos is likely to result. A man who loses his temper should not be in charge of men.

Many employers, when placing men in charge of gangs, tell them they like to see aggressiveness, and want them to get results regardless of obstacles. The ability to get things done is the greatest asset any foreman can have, but it must be kept in mind that this can be accomplished in two ways—by the aggressive type who sweeps everything before him, with the result that he makes enemies right along, or by the type who cooperates with others and arrives at the same results while maintaining friendly relations with all his associates. The aggressive type is gradually being pushed to the background, as intelligent employers realize that what they require more than anything else to get results is harmony in the organization. Where the spirit of harmony prevails, coupled with a knowledge of the job, you can count on getting results.

Checking up the Work of the Foreman

The departmental foreman is the backbone of any organization, but he must understand what his job is and what his responsibilities are. It is the duty of every general superintendent to see that his foremen understand their own job, and if they do not, to see that steps are taken to educate them in the responsibilities of the job they hold. If the general superintendent is not in a position to do this himself, he should delegate this authority to someone in whom he has confidence. The foremen should know that the results obtained in all the different departments are being checked up.

Qualifications of a Foreman

An efficient foreman should have the following qualifications. It will pay a foreman to study these qualifications from time to time to see that there are none that he is neglecting:

Character—By clean living and square dealing inspire the respect of your men.

Perseverance or *"Stick-to-it-iveness"* — When everything goes dead wrong, go at it again with a smile, and inspire the men to renewed energy.

Tact—Handle a difficult situation so that all parties will be pleased with the decision.

Power—Knowing that you are right, be able to inspire action in men who hesitate to believe in you. This does not mean a dominating personality that tries to reach out and grasp everything, overlooking the rights of others, but rather the ability, based on accurate knowledge, of showing others the error of their ways.

Initiative—Be able to apply new ways and means to perform work when other methods have failed, or improve on the present way of doing things.

Thrift—Perform the necessary work in the department at the lowest possible cost without earning or meriting the reputation of being stingy.

System—Plan work so that the maximum results will be obtained with a minimum of effort.

Humor—Be able to enjoy a laugh, even at your own expense.

Friendship—Be on friendly terms with every man in the department; every man should feel that he can approach the boss at any time and be given a fair hearing.

A man having these characteristics in his makeup will be an asset to any organization.

* * *

DEVELOPMENT OF DIESEL ENGINES

The rapid progress being made in the development of Diesel engines to meet larger horsepower requirements and for a broader application, is indicated in a recent article in *Mechanical Engineering*. One installation referred to is a single unit 15,000 horsepower, nine-cylinder, two-stroke-cycle, double-acting Diesel engine being built by Blohm & Voss of Hamburg for use in a power plant in Hamburg.

In the motor-liner field is mentioned the liner *Asturia*, built by Harland & Wolff of Belfast, having a gross tonnage of 22,000 and a speed of 15 1/2 knots. This ship contains two engines of the Burmeister & Wain type, rated at 7500 brake horsepower each, at a speed of 115 revolutions per minute. These engines are double-acting, four-stroke-cycle and have eight cylinders, 33 inches in diameter with a stroke of 59 inches. The height of this engine from the bottom of the bedplate is 36 feet, and the length is 60 feet. The total weight is about 700 tons.

The Broadening Field of Arc Welding

Application in Railway Field, Ship Construction, Street Railway Shops, Steel Mills, Oil Industry, Airplane Building, Steel Tank Manufacture, Building Construction and Mining Industry

By A. G. BISSELL, General Engineer, Westinghouse Electric & Mfg. Co., East Pittsburg, Pa.

WHEN arc welding first began to attract attention, it was in a field of limited application. But even in this limited field, which consisted of making minor repairs in railway shops and foundries, the extensive possibilities of utilizing the heat of the electric arc for construction and repair work, were so evident that its application has greatly increased in the last few years. This result is due, not only to the excellent results obtained by arc welding, but also to the research and study carried on by the manufacturers of electrical equipment, which have resulted in the design of suitable arc welding units.

Today the application of electric arc welding is almost unlimited. There is hardly an industry that does not have some use for this process. In the railroad shops, arc welding is indispensable. Flues are welded in the firebox end of the locomotives, increasing their life many times. Repairs to fireboxes are greatly simplified, and several railroads are building fireboxes entirely by arc welding. (See Fig. 1.) Broken locomotive frames are repaired perfectly by this process. In some railroad shops, worn flanges on locomotive drivers are built up without dismantling the locomotive, thus reducing the time that it is necessary for a locomotive to be in the shop. Many other uses of arc welding in railroad shops make this a very fertile field for the process.

Arc Welding in Shipyards and Street Railway Shops

In ship construction and repair yards, arc welding has been used advantageously in a number of ways. It has been substituted for riveting, with the result that stronger joints which are capable of withstanding rougher usage have been obtained. The construction of steel masts, skylights, ladders, rudders, deck stanchions, tanks, ventilators, and piping systems are some of the uses in the shipyards to which the arc welding process has been successfully applied. Again, it has proved itself useful in the installation of grab irons, deck fittings, bilge keels, and additions and changes in construction. In repair work, the arc welding process greatly reduces the time that a ship has to be laid up for repairs.

Many uses have been found for electric arc welding in street railway shops. The severe service to which street railway equipment is subjected means that the maintenance is high. Arc welding is especially adaptable for this class of work. It may be used to repair broken parts, to build up worn down surfaces, and it has been used in the construction of the running gear of street cars. (See Fig. 2.) Worn flanges in street car wheels are built up by using an automatic arc welding head, thus increasing the life of the wheels. On the tracks, arc welding is used for attaching bonds, constructing special track work, and building up worn and damaged rail ends and cross-overs.

Application in Steel Mills, Oil Industry, and Airplane Construction

In steel mills, arc welding saves thousands of dollars annually. The building up of worn gears and pinions, damaged pods on rolls, and similar work constitutes much of

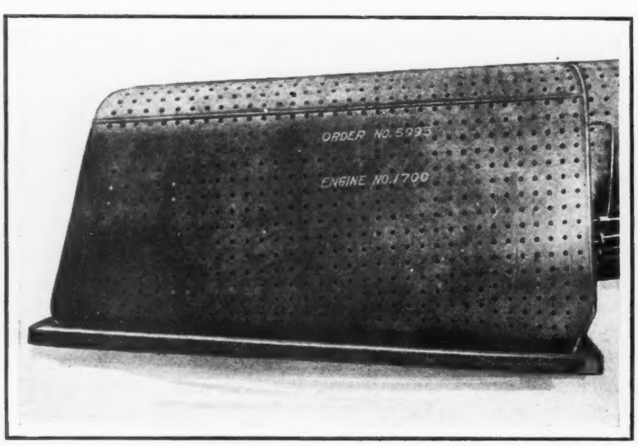


Fig. 1. Arc-welded Fire-box

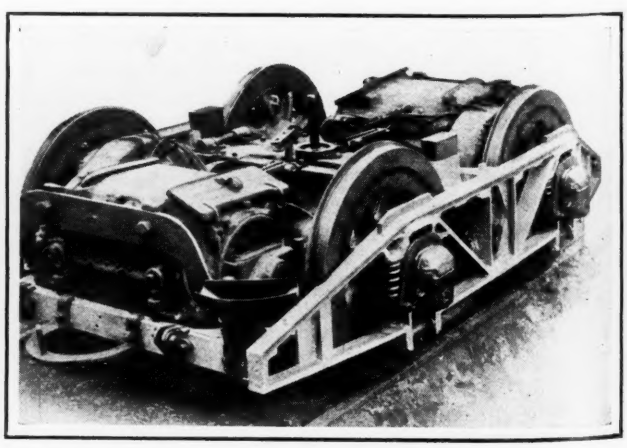


Fig. 2. Arc-welded Street Car Trucks

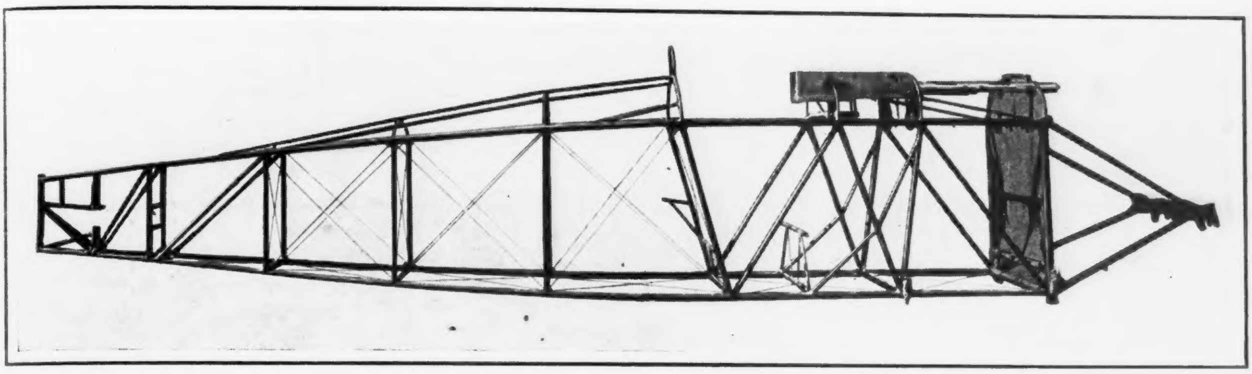


Fig. 3. Airplane Body completely arc-welded

the work in this industry. Most steel mills have their own locomotives and railway equipment which may be kept in repair more easily by using arc welding.

Great savings result from the use of arc welding in the oil industry. An arc welded storage tank has no tendency to leak, and leak-proof pipe lines are made by arc-welding the joints. In the drilling operations, the drills that have become worn and broken can be repaired and kept in good usable condition. Arc welded retorts and condensers in the refineries outlast the other types, as they are an integral structure and have no caulked seams to open up and leak.

Even in the construction of airplanes, arc welding has many applications. The assembly of steel fuselages has been most successfully accomplished by arc welding. (See Fig. 3.) The heat of the arc is so intense that a joint may be welded quickly with a minimum amount of warpage, which is quite desirable in this work.

Use of Welding Process in Steel Tank Manufacture, Building Construction, and Mining Industry

Another large field in which arc welding has been extensively used is in the manufacture of steel tanks. Tanks of all sizes and for all purposes can be made more economically and stronger by arc welding than by any other method. Here, again, the automatic arc welding equipment comes into use on the long seams in the tanks. By using this equipment, an entire seam can be welded without breaking the arc. Smokestacks, culverts, large-diameter pipes, and intricate pipe fittings and connections are all within the scope of the arc welding field.

In the erection of structural steel buildings, electric arc welding is being used to unite the members. A 60- by 40-foot mill type building recently constructed showed the erection cost, using arc welding, to be at least 40 per cent cheaper than by riveting. (See Fig. 4.) Tests have been made on welded joints in structural steel that show this type of joint to be stronger than the original members.

The mining industry has many applications for the arc welding process. Rail bondings, railway repairs, tank, pipe and flume construction, equipment repairs, and structural steel connections are but a few of the things that may be arc-welded around a mine property. In fact, almost all industries have metal parts that become damaged or broken, and therefore have use for electric arc welding. It is essential that electric arc welding be performed under the direction of a competent supervisor who has efficient well trained operators. Arc welding operations in any industry will be carried on, in most cases, in the repair shop or the production department. If the company is not very large, one welder will be able to take care of the production work and repairs. However, in the larger plants, more than one welder will be required. When the work is divided, one or more single-operator, arc welding sets can be used. A portable set may be used advantageously, because it can be moved from place to place where power outlets are provided. Thus, if the work at any one place does not utilize the entire time of the welder, one set will do for several locations. If, however, the work at any one location requires more than one operator, single sets may be installed for each operator required, or a single unit may be installed to supply current for either two, three, five, or eight operators.

* * *

The world's output of gold is slightly less than 10,000,000 ounces, valued at about $180,000,000. Of this South Africa yields about one-half, and all together, 71 per cent is mined in some part of the British Empire. The United States produces about 25 per cent of the world's output. It is interesting to note that the British Empire has a strong hold on certain natural products such as gold and rubber, for the full production of which the Empire has no need. On the other hand, sufficient supplies of oil are of the greatest importance to Great Britain, and of this commodity the Empire must buy large quantities.

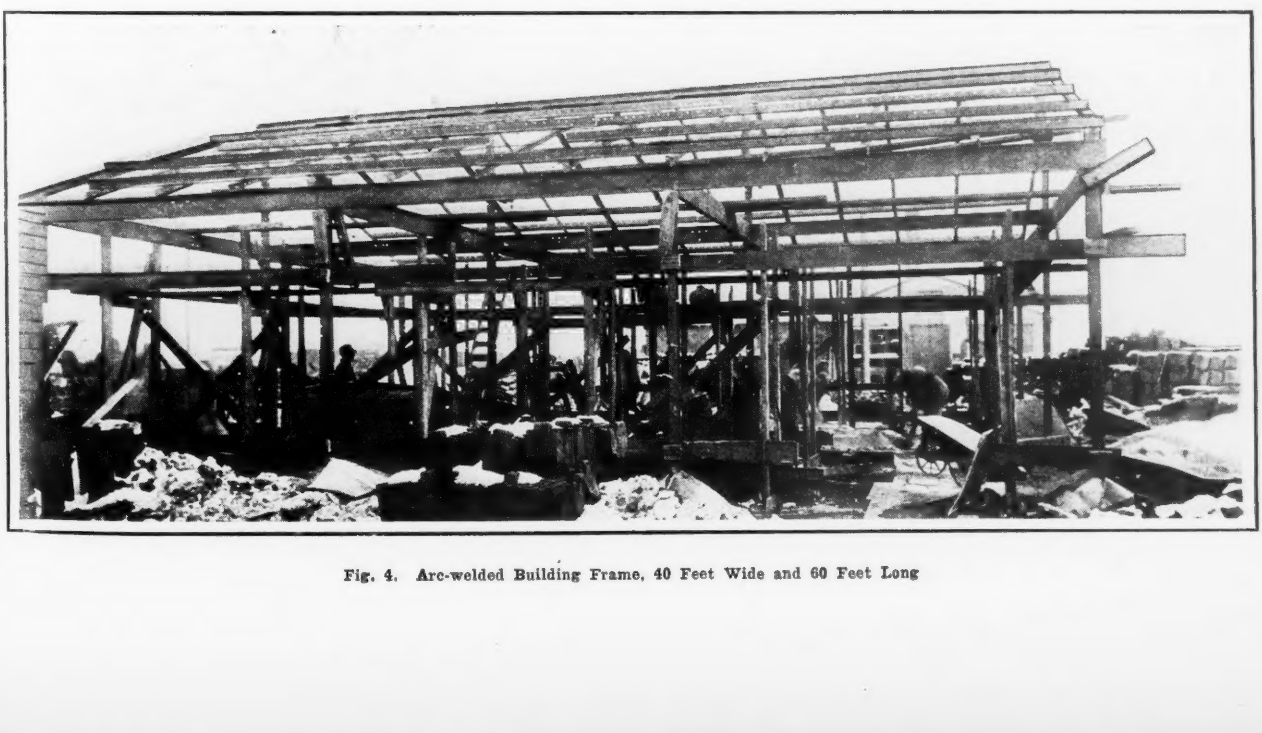


Fig. 4. Arc-welded Building Frame, 40 Feet Wide and 60 Feet Long

Repairing Milling Machines

By JACOB H. SMIT

JACOB H. SMIT was born in Amsterdam, Holland, in 1885. For the last twenty-six years he has been engaged in machine shop work and design, having acquired a broad experience in general machine building; repair of machinery; and tool work, including jigs, fixtures, gages, and blanking, piercing, bending and deep drawing dies. He has also had considerable experience in making molds for bakelite and condensite, and dies for die-castings. He has worked on the development of new inventions relating to special machines, taps, and reamers. Besides, he has had experience in inspecting, designing, and estimating work. His education includes a four-year technical school course at Alkmaar, Holland, and evening school courses in numerous subjects. Mechanical things are his hobby, and much of his technical knowledge has been acquired by home study through the reading of technical books and magazines. He arrived in the United States in 1910. He has contributed to a number of technical publications.

ALL shop managers who really understand their business will readily concede that it takes a mechanic longer to do a job on a machine needing repair than on one that is in first-class condition. When a machine is worn in its important parts, no amount of cleaning and reassembling, without repairing the defects, will make that machine satisfactory. If we analyze the reasons why machines wear, we find wear due to use; undue wear of the sliding or rolling parts due to lack of oil; and, often an important cause of wear, neglect to take up the slack in spindles, bearings, or slides, etc., when they become slightly loose. In some shops, it is the custom to oil machines only once a week, regardless of the speed at which the spindles are run; but once a week is not enough—a few drops of oil two or three times a week does more good than a large amount at one time. In oiling a machine, it is a good plan to oil the belt pulley first, then the spindles, slides, etc.

The repair of a milling machine is not an easy matter unless the procedure is understood. Due to wear and to the settling of cast-iron parts, the longitudinal and cross slides often do not line up with the spindle. If adjustments are not made in time to remedy the condition, when the gibs are finally tightened up, the slides will still be shaky, because of a faulty fit. In testing a milling machine to determine where corrections are required, use may be made of a pair of accurate parallels and a 10- or 12-inch angle-plate trued up on the sides of the upright and base in addition to the front and bottom. At the points where the parallels are to be laid on the table, the latter should be smoothed over lightly with a file. Then the slides and table should be cleaned off, the slides adjusted to a snug fit, and the main spindle tightened, if loose, and otherwise repaired, if necessary.

The parallels should then be laid on the table and the top of the parallels inspected for levelness by means of an indicator attached to the overhead arm of the milling machine. If the parallels are not true, they should be shimmed up until both are of the same height. The angle-plate should then be placed on top of the parallels with the face at right angles to the spindle axis.

Determining Errors in the Slides

In determining the amount that the cross-slide of the machine is out of square with the main spindle, the indicator is attached to a bent rod, held in the spindle of the machine, and is brought in contact with the front of the angle-plate; the spindle is then revolved to make the indicator sweep the angle-plate with as large a circle as possible—say 10 inches in diameter. The angle-plate should be shifted until the indicator gives the same reading in the two horizontal positions when the spindle is revolved, and then the angle-plate may be lightly clamped in that position. If the indicator shows a difference of 0.005 inch in readings taken at the top and bottom points of the sweep, and the point of the indicator is set 5 inches out from the center of the spindle, it will show the cross-slide of the machine to be 0.005 inch out of square with the spindle in a 10-inch movement of the cross-feed.

Next, by moving the table lengthwise and indicating along the face of the angle-plate, it may be determined whether or not the table moves exactly at right angles to the spindle axis. If the angle-plate is 10 inches wide and the indicator shows a difference of 0.001 inch between the two edges of the angle-plate, it will mean that the table, if 60 inches long, will be out 0.006 inch in the whole length. The squareness of the table relative to the spindle can also be determined by sweeping an indicator on one side of the table at both ends.

Bringing the indicator in contact with one side of the angle-plate base and feeding the cross-slide in or out, will show how much the cross-slide is out of line with the axis of the spindle in a certain length of travel. Finally, by moving the table up and down with the indicator touching, first the front and then one side of the angle-plate, it will be determined how much the vertical slide is out of square and out of alignment, respectively, with the spindle. The amounts that all slides are out of true should be carefully marked down on paper for reference in making the corrections.

The angle-plate and parallels are now removed preparatory to checking the top of the table. Chalk lines are scribed across the table, 3 or 4 inches apart, at right angles to the T-slots, and then lines are drawn on a sheet of paper to represent the table slots and the chalked cross-lines. A bar about 1/2 by 1 inch in cross-section is clamped on the overhead arm, and an indicator fastened to it.

With the indicator in contact with the table, the latter is moved lengthwise and crosswise to permit readings to be taken at each intersection of the chalk lines with the T-slots. These readings are marked carefully at the intersections shown diagrammatically on the paper. After readings have been taken at each intersection on the table, the table should be moved back to the starting point to insure that the indicator has not changed its position during the inspection. By studying the readings made with the angle-plate and on the table top, it can now be determined which parts to scrape —the cross-slide, table, or vertical slide, etc.—in order to make the machine true again.

The accuracy of the tests made with the angle-plate, of course, depends on the accuracy of the angle-plate and the setting of the parallels. An angle-plate can be conveniently tested for accuracy by means of a cylindrical plug or bushing, ground or turned straight and faced square on one end. With the angle-plate on a good surface plate, this plug is merely set in contact with the different surfaces of the angle-plate for determining errors. If the angle-plate is out of square, the amount should be deducted from or added to the readings obtained in inspecting the machine slides.

Making the Corrections

If the vertical and cross slides of the milling machine are out of line and it is decided to correct them, they should be trued up first. It should be thought out carefully where to

remove metal, because in scraping one slide, another may be thrown out of true. The machine should not be taken apart until the table is tested.

If only the table top needs truing up and more than 0.002 inch of stock is to be taken off, it pays to use a file. With the indicator clamped on the overhead arm, take successive readings at the places that need filing, and file until the table is true within 0.001 inch at any given point. A piece of felt can be used for rubbing red lead on the table, and the surface plate applied to show up the high spots. Move the surface plate back and forth a few times; then scrape the exposed surfaces of the table, clean off, rub in more red lead, and again apply the surface plate as before. Repeat this procedure a few times, and if headway is made, take off the surface plate and again apply the indicator to check the scraping.

To obtain a good finish, use a scraper sharpened with a fine oilstone. After red lead has been rubbed into the table, scrape the table lightly one way for the entire length. Again, rub in red lead, and scrape lightly the entire surface at an angle of about 45 degrees to the previous marks, but leave narrow widths uncovered. Then rub in red lead for the final step, and scrape at an angle of 90 degrees to the marks of the second scraping, again leaving narrow spaces between the marks. Finally, wash off the surface with kerosene, gasoline, or machine oil. By using this method and a fair amount of energy, a medium-sized milling machine table can be tested and scraped true within less than 0.001 inch (if the table is not out more than 0.006 inch at any point at the beginning of the scraping operation) in from eight to twelve hours. The feed-screw thrust collar should be examined in correcting the table, and if grooved on the faces, should be trued up.

* * *

ELECTRICAL PROSPECTING

"Electrical prospecting" is the name now generally used for the new scientific method of prospecting for minerals. The modern prospector carries a coil of wire instead of a pick, and uses his ears and the science of mathematics in place of the searching eye that tried to catch the glint of a mineral. Instead of breaking up bits of rock, he straps telephone receivers to his ears and listens carefully, or notes the slight motion of the hand of a voltmeter. In this way he is able to discover deposits of ore hidden beneath the water and the bed of a lake. Prospecting of this kind is described in the *Swedish-American Trade Journal* as follows:

"It is the dead of winter in northern Sweden, where the days are only a few hours long and the cold is continuously intense. On a frozen lake where the ice is three feet thick we see a small group of men. One of them is holding a wooden frame, and inside the frame is a small coil of wire. Around the group on the ice stretches a huge circle of larger wire, about 250 feet in circumference. A little gasoline motor is kicking up clouds of steam nearby.

"The men move around from time to time, and whenever they stop at a new spot on the ice they hold the wooden frame at a certain angle in the air and carefully watch a voltmeter attached to the coil within. They mark down certain figures in a notebook and move on again.

"This goes on for several days. Then the men disappear, taking their wire and motor and other paraphernalia with them, and the ice-covered lake is once more deserted. For three months nothing happens. But one day a crowd of men—much bigger than the first band—arrives. With them they have a large drilling machine. They haul it out on the ice to a spot indicated by one of the men of the first expedition and there begin to drill down through the frozen sheet that covers the lake.

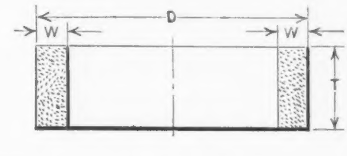
"Down through the ice, down through thirty feet of water, down through ten feet of mud, and then—down into a vein of rich copper-bearing ore. It is not luck. It is because those men with their coils of wire and their gasoline engine have been able to locate the copper with the aid of electricity and mathematics, even though the ore was hidden beneath the bottom of a frozen lake."

ADDITIONAL STANDARD CYLINDER WHEELS

For many years the grinding wheel manufacturers have been endeavoring to draw up a set of standards for shapes and sizes of grinding wheels. This was felt to be of prime importance in order to curb the rapidly increasing number and variety of shapes and sizes called for, many of which were known to be unnecessary for the service they were to perform, and were therefore the cause of needless complication and largely contributed to one of the greatest preventable wastes within the industry. In drawing up these standards, every effort was made to provide practical shapes and sizes for all major classes of grinding, such as would be acceptable to the trade and the adoption of which would entail a minimum of effort and expense on the part of the user. The task was found to be a very difficult one, as grinding wheels are used for a multitude of purposes.

When the work was finally considered temporarily completed, therefore, and the standards as adopted by the Grinding Wheel Manufacturers' Association of the United States and Canada were published in booklet form several

CYLINDER GRINDING WHEELS
Type No. 2



D	T	W	D	T	W
8	4	1	18	5	1 1/4
10	4	1	18	5	1 1/2
12	4	1 1/2	18	5	4
14	4	1 1/2	18	6	2
16	4	2	20	6	2 1/2
16	5	1 1/4	24	6	2 1/2
16	5	1 1/2	30	6	3

Machinery

months ago, it was realized that the entire field had not been covered, and that certain additions or changes in the lists and tables of standard wheels might be necessary.

While the standards as published met with general approval throughout the trade, it became apparent that the table of standard cylinder wheels did not contain a sufficient number of sizes to cover the major grinding operations for which wheels of this type are used. It was felt that this condition ought to be corrected promptly, and five sizes, all of which are in popular demand, were added to the list of standard cylinder wheels originally published and reprinted in MACHINERY's Data Sheet No. 68, New Series, October, 1925. The revised table of standard cylinder (Type 2) wheels is published herewith. The added sizes are all 5 inches in height.

* * *

STANDARDIZING THE DESIGNATION OF SIEVE SCREENS

A new method of designating sieves by the size of opening in "microns" has been recommended in order to eliminate confusion in ordering or specifying screens. The old method of designating screens by the number of openings per inch was considered unsatisfactory, because it gave no direct indication of the size of the openings; if the size of wire was varied, the size of the opening would also be varied. Thus, unless a standard size of wire for a given sieve was decided upon, the openings might vary considerably. The new method of designating the sieves by the size of opening in microns seems to overcome the objections to the older method. The micron is equivalent to 0.001 millimeter, this unit being adopted so that all sieve sizes can be designated in terms of whole numbers. This method has been approved by the American Society for Testing Materials.

FINISHING THE INNER GUIDES OF PLANER BEDS AND TABLES

By CARL E. LINDEN

On the bed of planers built by the Cincinnati Planer Co., Cincinnati, Ohio, there is a finished narrow vertical surface extending the entire length inside of each vee, as shown at *A*, Fig. 1. These two "inner guide" surfaces contact with corresponding surfaces on the table to eliminate any tendency of the table to shift or climb out of the bed vees when heavy cuts are being taken by tools in the planer side-heads, or by tools in the rail-heads when they are high above the table. The distance between the inner guide surfaces must be accurate within 0.0015 inch. In the following paragraphs the methods followed in attaining the accuracy specified will be described.

Rough-planing the Inner Guides of the Bed

When the rough bed casting is first placed on the table of a planer for finishing the various surfaces, it is roughly leveled and clamped in place with the top side down. One housing cheek and the bottom of the bed are then planed by the side- and rail-heads respectively, after which the bed is turned over, and again leveled and clamped preparatory to rough-planing the opposite housing cheek, the inner guides, the vees, and other top surfaces. Next the clamps are again loosened, and the bed peened all over to relieve any strains in the casting. This peening produces the same results as seasoning would.

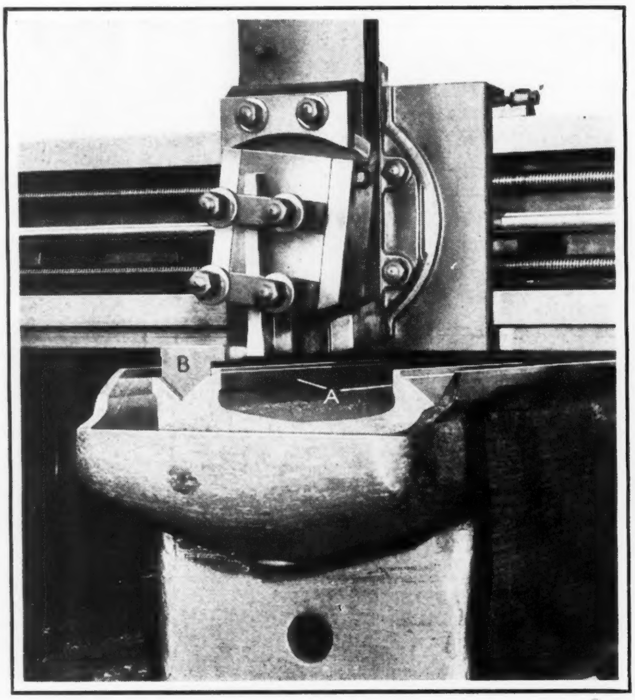


Fig. 1. Method of setting the Tool in the Second Rough-planing Operation on the Inner Guides of the Bed

Upon the completion of the peening, the bed is reset and again clamped. Then the different top flat surfaces are finish-planed, and the vees rough-planed a second time, and then finish-planed. The vees are finished to standard half templets, so as to insure the correct distance between the vees and the proper angle between the vee surfaces. The next step consists of rough-planing the inner guides *A* a second time. To insure the correct setting of the tool for these cuts, use is made of gage *B*. This gage is simply laid in the finished bed vee, and the tool properly located for the cut by bringing it in contact with the vertical inner gage surface as shown. When one inner guide has been rough-planed, the same gage is laid in the other bed vee to set the tool for planing the other guide.

Gaging Fixture for Finish-planing the Guides

In finish-planing the inner guides, use is made of the gaging fixture illustrated at *C*, Fig. 2, which is provided with a plug *D*, ground flat on one side near the lower end. There is a bushing in the cross-piece of the fixture into which the plug may be inserted, with the lower end extending as shown. As the finish-planing progresses, the fixture is placed in the bed vees from time to time, and the plug inserted through the hole with the flat surface against the inner guide. When the flat surface on the plug becomes just "feeler tight" against the inner guide, the desired accuracy has been attained. The gaging fixture is turned end for end for use in checking the planing of the opposite inner guide.

In planing the inner guides of the table, the same procedure is followed as in the case of the bed, with the exception that templets and gages of the female type are used. One of the table gaging fixtures is illustrated at *E*, Fig. 3, with the bed gaging fixture *C* upon it. From the position of plug *D*, it will be obvious that a hole is located in the table fixture in the same relative position as the hole in fixture *C*. Thus, in finish-planing the inner guides of the table, a plug similar to *D* is inserted through the bushing in fixture *E* to determine when the guides have been finished to the proper fit. Plug *F* is used to check the height of the surface that is finish-planed on the bottom of the table to suit the rack, and plug *G* is used for checking the top of the inner guides.

* * *

Exports of motor vehicles during 1925 were more than 550,000, or 12 per cent of the total output. Present prospects indicate that foreign markets will call for more than 700,000 American motor vehicles during 1926.

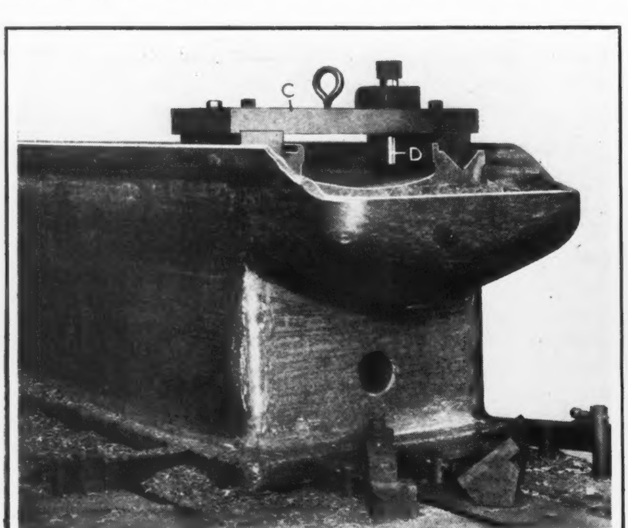


Fig. 2. Gaging Fixture used in determining the Fit of the Inner Guide Surfaces during the Finish-planing

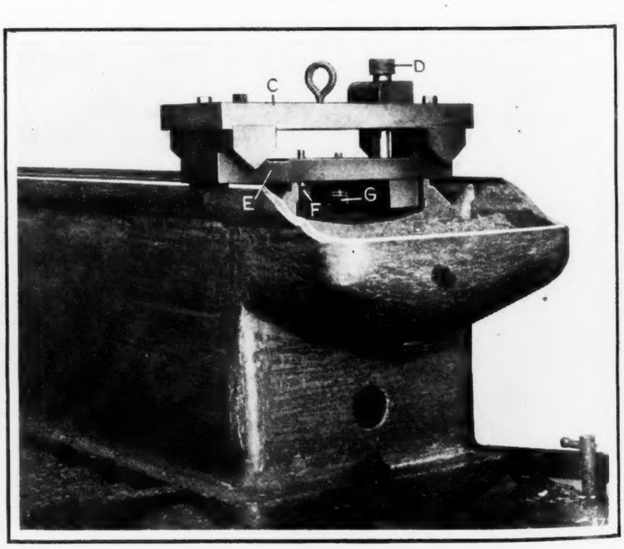


Fig. 3. Bed Gaging Fixture used in Connection with Table Gaging Fixture for checking Inner Guides of Table

RULES FOR FIGURING PULLEY SPEEDS

By B. M. FINE

It is sometimes desirable to change the speed of a machine drive shaft a definite number of revolutions per minute by changing the diameter of one or more of the follower or driving pulleys. The new pulley diameters can, of course, be figured by well-known rules, but to do so, necessitates determining the speed of the line or primary shaft, which is not always known or conveniently obtained. Thus the arithmetical work is generally lengthy.

More direct rules dealing only with the items involved are therefore desirable. The following rules have been worked out so that the only data required is the diameter of the driver or follower pulley to be changed, the speed of the final shaft, and the required change in speed. In many cases, the solution of the problem can be obtained mentally, which is an advantage when studying an installation, to determine which pulley can be most conveniently changed.

Rule No. 1—To find the change in the diameter of any driver pulley in a train necessary to obtain a given change in the number of revolutions per minute of the final shaft, multiply the diameter of that driver by the change in revolutions per minute, and divide the product by the present speed of the final shaft in revolutions per minute.

Rule No. 2—To find the change in the number of revolutions per minute of the final shaft for a change in the diameter of any driver in the train, divide the present number of revolutions per minute of the final shaft by the diameter of the driver to be changed, and multiply the result by the change in diameter of the driver, expressed in inches.

Rule No 3—To find the decrease in the number of revolutions per minute of the final shaft for a 1-inch increase in the diameter of any follower in the train, divide the present number of revolutions per minute of the final shaft by the diameter of the follower plus 1. For a 1-inch decrease in the diameter of any follower in the train, divide the number of revolutions per minute of the final shaft by the diameter of the follower minus 1 to find the increase in speed of the final shaft. (For a 2-inch or 3-inch, etc., change in the diameter of a follower, subtract or add either 2 or 3, as the case may be, to the diameter of the follower, divide the number of revolutions per minute of the final shaft by this sum, and multiply the result by the number added or subtracted.)

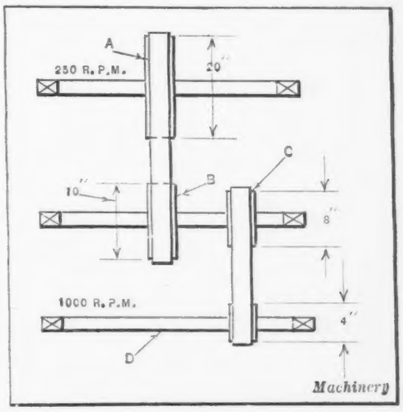
Rule No. 4—To find the decrease in diameter of any follower in the train for a given increase in the number of revolutions per minute of the final shaft, multiply the diameter of the follower by the change in revolutions per minute, and divide the product by the sum of the present final shaft speed and the desired change in speed, expressed in revolutions per minute. To obtain the increase in diameter of any follower required for a decrease in the number of revolutions per minute of the final shaft, multiply the diameter of the follower by the change in speed, in revolutions per minute, and divide the product by the difference between the present number of revolutions per minute of the final shaft and the desired change in speed, in revolutions per minute.

As an example, let it be assumed that it is desired to run the shaft *D* shown in the accompanying illustration 100 revolutions per minute faster than its present speed of 1000 revolutions per minute. The speed of the driver *A* may be increased by employing Rule No. 1, in which case we have the diameter of the pulley *A* times 100 divided by 1000 equals 2 inches. Two inches added to the diameter of pulley *A* gives us a diameter of 22 inches for the new pulley.

The shaft *D* could also be given the required speed of 1100 revolutions per minute by increasing the diameter of pulley *C*, in which case we would have 8 times 100 divided by 1000 equals 8/10 inch, which is the increase in the diameter of pulley *C* required to give shaft *D* a speed of 1100 revolutions per minute. Instead of increasing the diameter of the driving pulley, the required speed of shaft *D* could be obtained by decreasing the diameter of the follower *B*, according to rule No. 4, in which case we would have 100 times 10 divided by 1000 plus 100, which equals 10/11 inch. Thus we would use a pulley *B* of 9 inches in diameter, which is the nearest standard size, unless a change in the speed of exactly 100 revolutions per minute is required.

The follower on shaft *D* could be changed to obtain the required speed instead of changing follower *B*. If the follower on shaft *D* is changed we have 100 times 4 divided by 1000 plus 100 equals 4/11 inch, which represents the required decrease in the diameter of the pulley on shaft *D* to obtain a speed of 1100 revolutions per minute for this shaft.

Referring to the accompanying illustration and applying Rule No. 2, it will be obvious that a change of 1 inch in the diameter of pulley *A* will change the speed of shaft *D* 50 revolutions per minute, and a change of 1 inch in the diameter of pulley *C* will result in changing the speed of shaft *D* 125 revolutions per minute. Also, it will be noted that for a change of 2 inches in the diameter of these pulleys the resulting change will be twice as great as when the pulley diameter is changed 1 inch.



Pulley and Belt Drive Diagram used to illustrate Application of Formulas

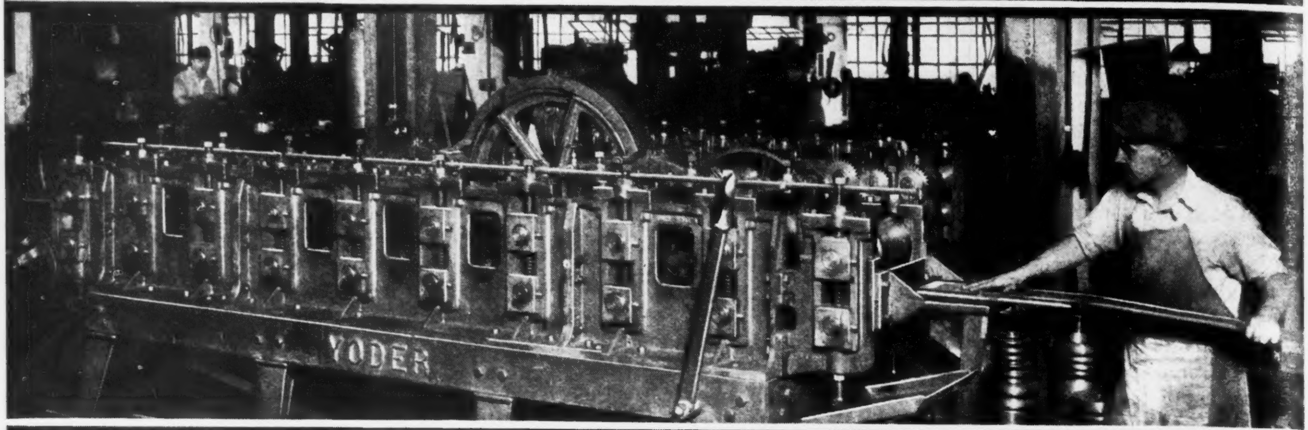
If the diameter of pulley *B* is increased 1 inch we have, according to Rule No. 3, 1000 divided by 10 plus 1 equals 90.9, which represents the decrease in revolutions per minute of shaft *D*. If we decrease the diameter of pulley *B* 1 inch we have 1000 divided by 10 minus 1 equals 111.1 revolutions per minute, which represents the increase in the speed of shaft *D*. For a 2-inch increase in the diameter of pulley *B* we have 1000 divided by 10 plus 2 equals 83.3. Now 2 times 83.3 equals 166.6 revolutions per minute, which represents the decrease in revolutions per minute of the shaft *D* when the size of pulley *B* is increased 2 inches.

If we decrease the diameter of pulley *B* 2 inches we have 1000 divided by 10 minus 2 equals 125. Now 125 times 2 equals 250 revolutions per minute, which represents the increase in the speed of shaft *D* when the diameter of pulley *B* is decreased 2 inches. If it is desired to obtain the required change in speed by changing the diameter of two or more pulleys, this can readily be done by dividing the required change by 2 or 3 as the case may be, and calculating the change in the diameter of each pulley required to permit it to effect its required part of the change in speed.

* * *

SCIENCE AND ENGINEERING

In looking back over the history of science and engineering, one is confronted by the fact that long intervals of time generally have separated a scientific discovery from its practical application. About two thousand years separated the observation that rubbed amber would attract light objects and the first practical use of electrical phenomena. *Engineering* points out that the rapid spread of scientific knowledge and the extraordinary growth of the mechanical arts which commenced a century and a half ago have materially diminished the gap between laboratory experiments and their commercial exploitation; but nevertheless, many years elapsed between Davy's work on electrolysis and its practical application in the electroplating industry, and nearly forty years intervened between Faraday's discovery of electro-magnetic induction in 1831 and the construction of the first Gramme dynamo electric machine in 1869. Of late, discovery and application have come much closer together, less than ten years having elapsed between the discoveries by Hertz in the field of Maxwell's electro-magnetic waves and their practical application by Marconi. It is evident that the relation between the laboratory and the practical engineer is becoming a closer one with the advance of both science and engineering.



Rolling Sheet-metal Sections

Cold-forming Sheet-metal Sections to any Length by the Use of Machines Equipped with Multiple Rolls

SHEET-METAL sections of steel, copper, tin, and similar materials, find an almost endless variety of applications. They are extensively used in the construction of buildings, for window frames, window sashes, molding, and beading of the kind used vertically at the corners of rooms to hold plaster in place. A good deal of molding is made use of in the construction of railway cars and automobiles, and many other sheet-metal sections are used in the manufacture of metal furniture. Angle- and channel-sections are easily produced from sheet metal, as well as freight car roofing, garage roofing and side sheets, butt-seam tubing, etc. Machines for rolling sheet-metal sections in one operation, with the material cold, handling sheets up to 48 inches wide and up to No. 10 gage steel, are built by the Yoder Co., Cleveland, Ohio. The heavier sections are produced at speeds ranging from 50 to 90 feet per minute, and the lighter sections at speeds of from 75 to 200 feet per minute. In addition to the speed of operation, one of the features claimed for this "cold-roll forming" process is that sections of any length can be rolled. This article describes the methods followed in producing a number of sections.

Construction of Cold-roll Forming Machines

Two general types of machines are built by the company mentioned; the machines used for the heavier sections have the rolls supported in bearings on both ends, while the rolls of the machines used in forming light sections of copper, tin, and steel up to No. 20 gage, are held in bearings on only one end, the opposite end of the rolls overhanging. A typical machine used for producing heavy sections is shown in the heading illustration, and Fig. 1 shows a view taken from the left-hand end of this machine.

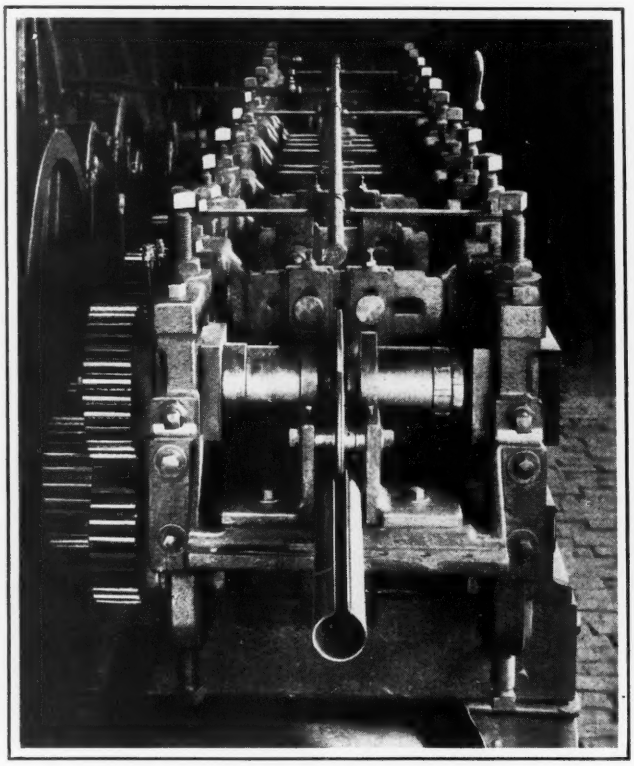


Fig. 1. Arrangement of Rolls in Type of Machine used in cold-roll-forming the Heavier Sheet-metal Sections

Both types of machines are made up of a multiple number of roll units mounted on a long bed. The different units may be provided with one, two, or four pairs of rolls, the total number depending upon the kind of material and the shape of section to be formed. Between each pair of rolls is a stand on which a guide is mounted to keep the metal strip in line with the rolls. Each stand is also provided with shoes which hold the strip at the proper height relative to the rolls. Most of the rolls are driven through gears at the rear of the machine, but sometimes idler rolls are placed between the driven ones. The driven rolls not only form the material but also feed it through the machine.

The first pair of rolls are usually plain cylinders, and are entirely feeding rolls. Occasionally, however, these rolls start forming the metal, in addition to feeding it into the machine. The other sets of rolls are of different shapes so as to form the section progressively as the strip of metal goes through them. In designing the rolls for a given section, some point on the section is selected as the point where all the driven rolls shall pinch the metal slightly to pull it through the machine. The rolls are then so designed and installed that the gripping points of all the rolls are in the same horizontal and vertical planes. Hence

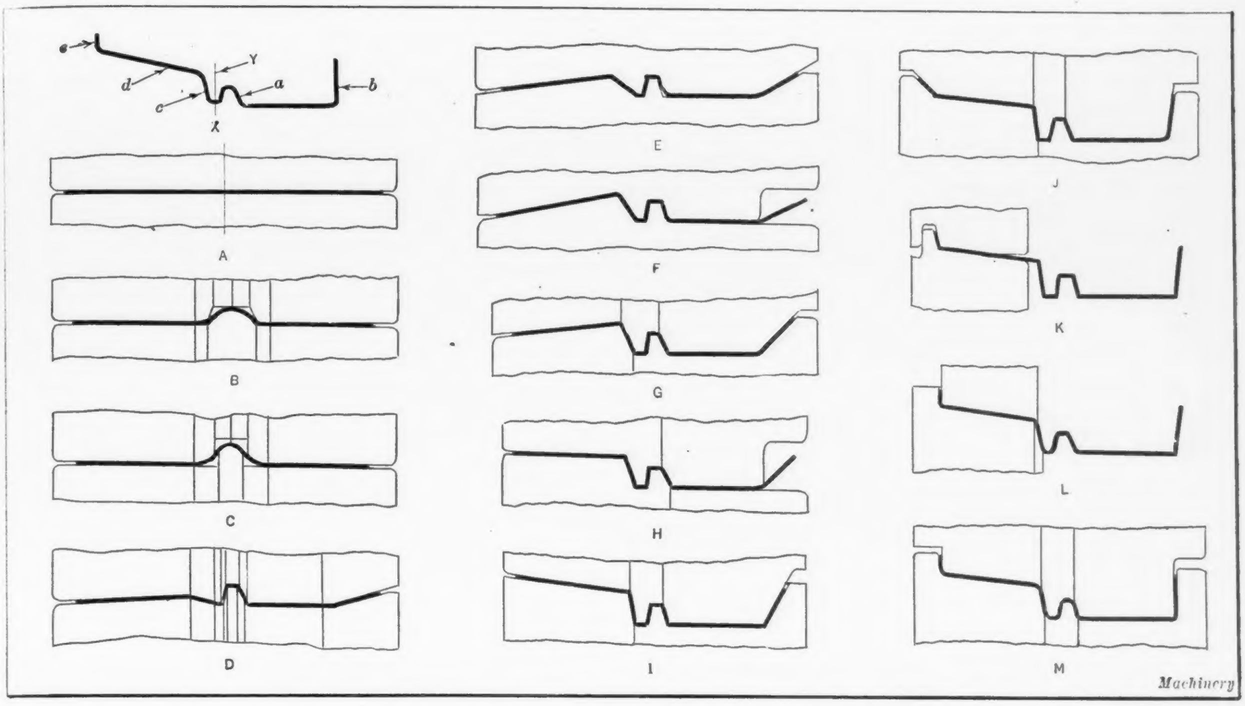


Fig. 2. Successive Steps in forming a Sheet-metal Window-sill Section

all rolls are of the same diameter where they pinch the stock, so as to feed the material at a uniform rate. The diameter of the rolls at this point is called the "normal" diameter. In most instances, the rolls start to form the section at the middle and work outward, but sometimes the opposite method is preferable. All rolls are made of steel, hardened and ground.

Forming Window Sills

Thirteen pairs of rolls are employed in forming the window-sill section illustrated at *X*, Fig. 2. Of these, ten pairs are driven and the other three pairs are idlers. The final driven rolls pinch the section along the center line *Y*, and so the diameters of these rolls at point *Y* constitute the normal diameters of all the rolls. This section is made from No. 12 U. S. gage steel, which is delivered to the machine in strips 10 1/2 inches wide. When finished, the piece is about 7 1/2 inches wide.

The first pair of rolls are plain cylinders, as outlined at *A*, because they simply feed the stock into the machine. Rolls *B* commence drawing the metal up at the middle to form ridge *a*, and this process is continued by rolls *C*. Ridge *a* is finished by rolls *D*, which also start forming leg *b* and ridge *c*, and bend surface *d* downward. Leg *b* is bent upward further by rolls *E*, which also continue forming the different surfaces of portion *c* and bending surface *d* downward. Rolls *F* are idler rolls, which continue the forming of portion *c*.

Portion *c* and leg *b* are further formed by rolls *G*, while idler rolls *H* work on portion *c* and surface *d*. The ninth pair of rolls, shown at *I*, commence bending surface *d* upward and continue forming portion *c* and leg *b*. Rolls *J* work on the same surfaces and start forming leg *e*. Idler rolls *K* continue the bending of leg *e*, and rolls *L* complete this leg. Rolls *M* finish or straighten the section. This window-sill section is run through the machine at the rate of 60 feet per minute.

Producing a Barn-door Track and Cover Section

Two pieces that are used together are illustrated at *X* in Figs. 3 and 4. The piece illustrated in Fig. 3 is a barn-door track which is used with the long leg standing upward and with the wheels of the door running on the short leg. The part shown in Fig. 4 is a guard or cover section which hangs over the front of the track to protect it from the weather. The track is made from No. 14 U. S. gage steel sheets, 5 3/16 inches wide, and the cover from No. 16 U. S. gage steel, about 7 inches wide. When finished, the track section measures about 4 1/4 inches wide, and the cover, about 6 1/4 inches.

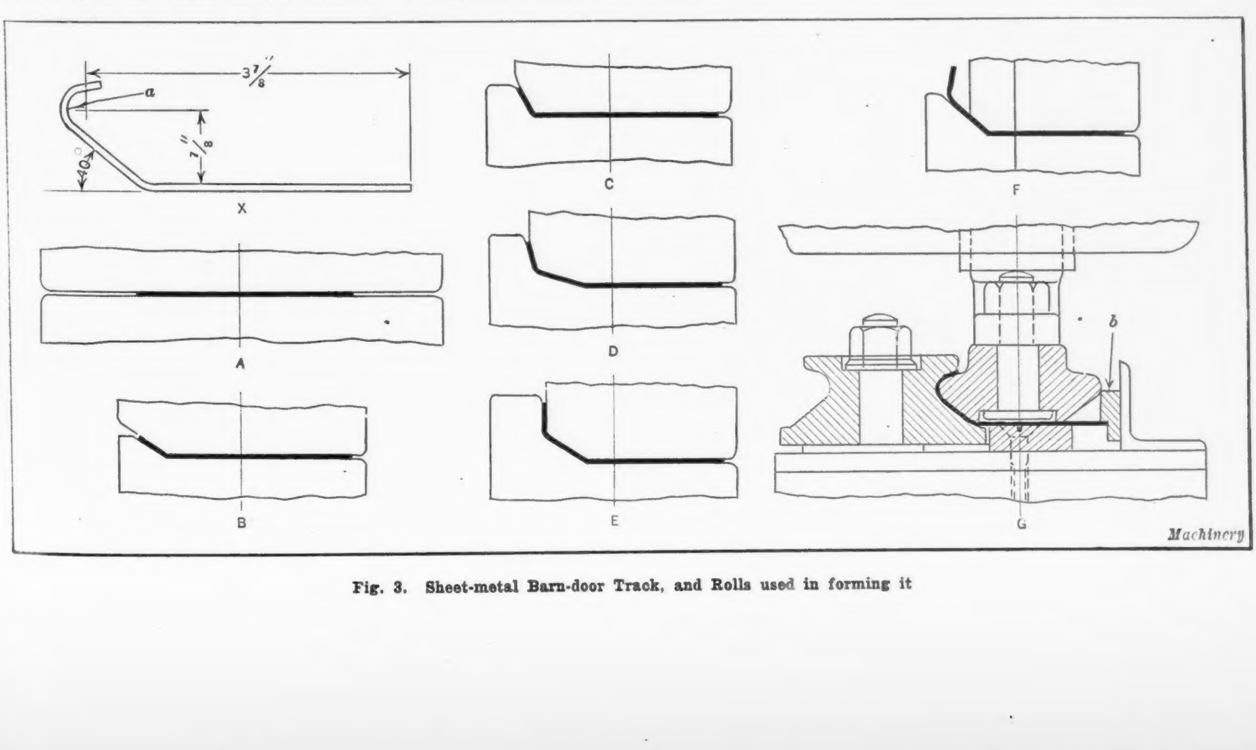


Fig. 3. Sheet-metal Barn-door Track, and Rolls used in forming it

Nine pairs of rolls are employed in producing the track, seven of which are outlined in Fig. 3. Rolls *A* simply feed the strip of stock, while rolls *B* and *C* start bending up edge *a*. A second bend on the same end is started by rolls *D* and continued by rolls *E* and *F*. After leaving rolls *F*, the material passes through idler rolls *G*, one of which revolves on a vertical stud fastened to a beam that extends across the housing of the machine. The second roll also revolves on a vertical stud. These rolls form the bent end to a radius of 1/4 inch at *a*. While the stock is being fed through them, the opposite edge is guided by piece *b*. When the piece leaves these idler rolls, it has been bent to the desired form, but it is run through two more pairs of driven rolls of the same design as the pair shown at *F*. These assist in pulling the stock through the idlers and "set" the section. In this operation, the speed of the work is about 100 feet per minute, and the normal diameters of the rolls are along the center lines shown.

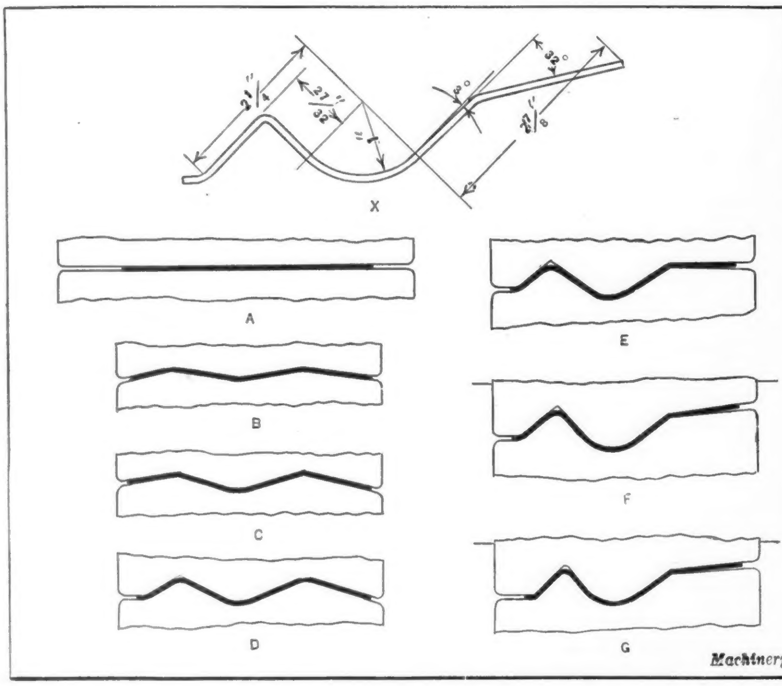


Fig. 4. Guard for the Track illustrated in Fig. 3, and Diagrams of the Rolls used in forming this Guard

As illustrated in Fig. 4, rolls *A* for the piece that mates with the barn-door track are simply feed rolls, and rolls *B* and *C* bend the metal upward at two points. In addition to bending the material at these two points, rolls *D* commence bending the left-hand edge upward. Rolls *E*, *F*, and *G* are all of the same general design, and finish the piece to the specified dimensions. The stock travels through this machine at the rate of about 100 feet per minute, and the normal diameters of the rolls are along the center lines shown.

At *X* in Fig. 6 there is shown a show-case molding which is rolled in the overhanging type of machine from copper sheets 0.032 inch thick and 2 5/8 inches wide. In this example, the feed rolls start forming the metal, as may be seen at *A*, and produce groove *a*. Rolls *B* bend edge *b* and start working the material for forming surfaces *c*, *d*, and *e*. Edge *c* and surface *d* are finished by rolls *C*, which also start bending the side *f* upward. The bending of this side is continued by rolls *D* and these rolls commence bending surfaces *d* and *c* upward together. As the surface *f* gradually nears completion, the metal is forced down relative to the bottom rolls to permit the forming of surfaces *g* and *h*.

Rolls *E* carry the work of rolls *D* further, and rolls *F* function similarly, except that they also commence rounding surface *h* and forming surface *g*. Rolls *G* and *H* are much the same in design as rolls *F*, and finish the section to the desired form. In producing this section, the material is pinched at the center of groove *a* by the different rolls for feeding. The speed of operation is about 100 feet per minute.

An unusual feature of the operation illustrated in Fig. 5 is the use of mandrels on the inside of the section to keep the width within limits of a few thousandths inch. Ten pairs of rolls are employed in forming this section, and two of these pairs are idlers. One of the driven pairs is unique in that only one roll is driven, the other roll being made with a double bevel where it comes in contact with the work, and inclined at an angle, as shown at *F*. No. 20 gage steel in strips 2 3/8 inches wide is the material from which the section is rolled, and the operation is performed in the overhanging type of machine.

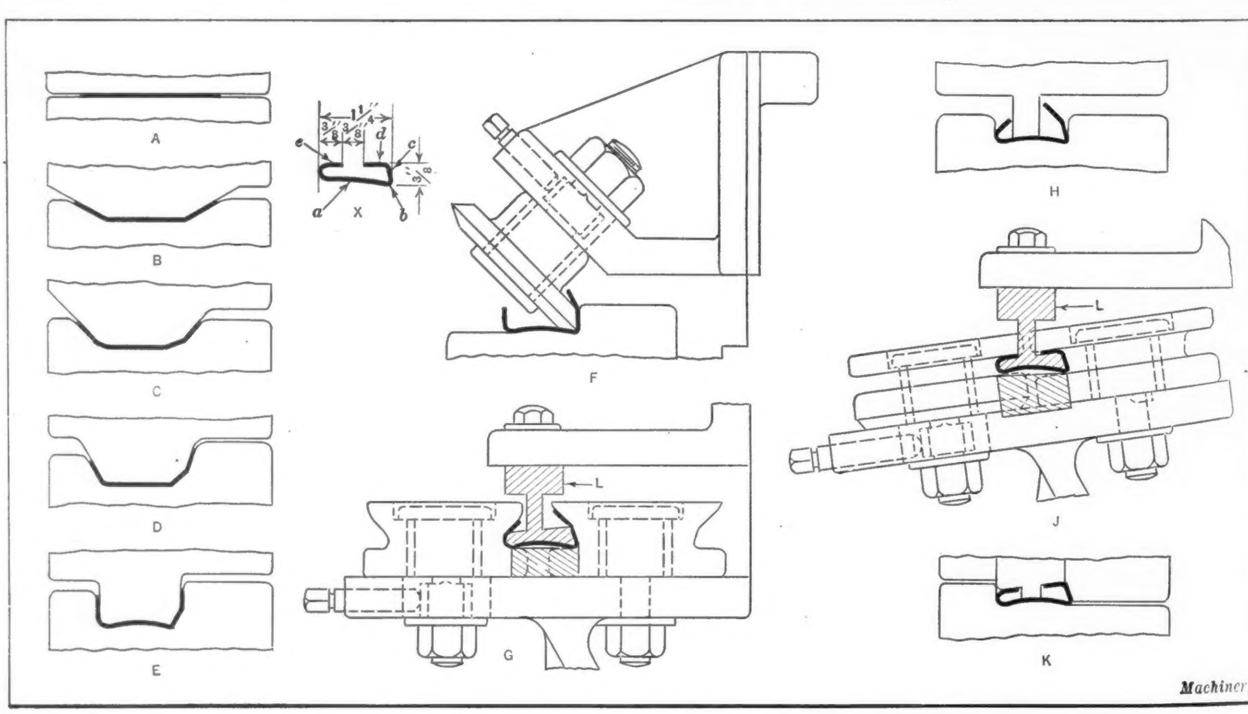


Fig. 5. Rolls employed in producing a Section that requires the Use of Mandrels to maintain the Inside Dimensions

As may be seen at *A*, the feed-rolls are of the plain cylindrical type. Rolls *B* bend the material upward on both sides, and rolls *C* continue this process, forming a double bend on the right-hand side. Rolls *D* and *E* bend the sides further, and, in addition, rolls *E* curve the lower side *a* to a radius of 4 inches. The unusual upper roll of pair *F* "sets" the sharp corner *b* and exerts a pressure on the side *c* that starts bending the top edge *d* downward. Rolls *G* constitute a pair of idlers that rotate about vertical shafts to bend the two sides of the molding and edges *d* and *e* around mandrel *L*. This mandrel is suspended between the rolls from overhead.

Rolls *H* are a pair of driven rolls, the sole purpose of which is to feed the work into the next pair of idler rolls, which are shown at *J*. These rolls are similar in design to the pair illustrated at *G*, but they are inclined at an angle with the bed of the machine, because of the slanting right-hand side of the section. In this case, the section is brought to the final shape as the rolls bend it over mandrel *L*. Rolls *K* are simply used to bring the various surfaces of the section to the proper size within the specified limits.

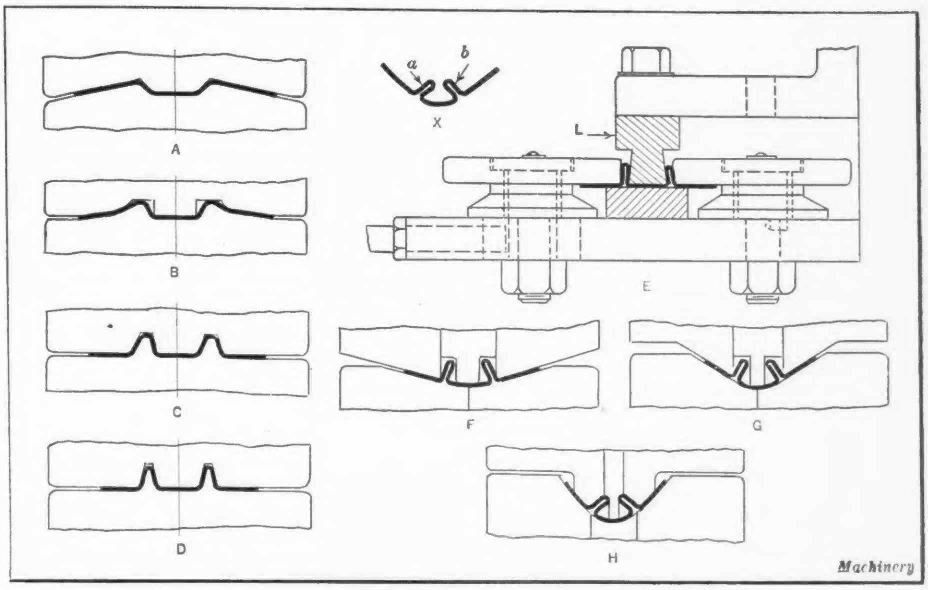


Fig. 7. Consecutive Steps in producing a Small Section having Two Loops

Forming a Section with Two Loops

A great deal of thought was required in designing the rolls for forming the section shown at *X*, Fig. 7. This section is used to support the large window panes of stores. The edges of two different panes bear against surfaces *a* and *b*, and these surfaces may be at different angles relative to each other, as required. In the example illustrated, they form a right angle. Sheet copper 0.040 inch thick and 3 7/32 inches wide is used in forming this section, which is about 1 1/2 inches wide when finished. This operation is also carried on in the overhanging type of machine with the work fed through at the rate of about 100 feet per minute. Each pair of driven rolls pinches the stock at the center to feed it through the machine.

In this example, the feeding rolls illustrated at *A* commence drawing up the metal at two points to form the loops. This process is continued by rolls *B*, *C*, and *D*. The fifth pair of rolls, which is shown at *E*, consists of idlers that flatten the loops against mandrel *L*. These two rolls are mounted on vertical studs with the mandrel suspended between them, as in the preceding operation. Rolls *F*, *G*, and *H* round the bottom of the section and bend the edges upward to produce surfaces *a* and *b* at an angle of 90 degrees relative to each other. A ninth pair of rolls (not shown) bends each edge of the section slightly for a distance of about 1/8 inch. When the angle between the sides *a* and *b* is to be other than 90 degrees, the ninth pair of rolls also bends these surfaces to the desired angle. The stock is carried through this operation at a speed of 100 feet per minute.

* * *

STANDARDIZATION OF WIRE AND SHEET-METAL GAGES

The Society of Automotive Engineers has requested the American Engineering Standards Committee to take up the standardization of methods of designating the sizes of wire and metal sheets and plates. The problem in its entirety will be submitted for the consideration of all industrial groups concerned, by the American Engineering Standards Committee and the Division of Simplified Practice of the Department of Commerce. As one of the first steps, the American Engineering Standards Committee will in the near future call a conference of all groups interested, to discuss the desirability and possibility of unifying the various existing gage systems into a consistent national system or systems. The Division of Simplified Practice will undertake to bring about production surveys, and will shortly address industrial groups interested in the different phases of the subject in regard to this side of the question. The American Engineering Standards Committee will also prepare a memorandum on the gaging systems for wire and sheet metal at present in use in this country.

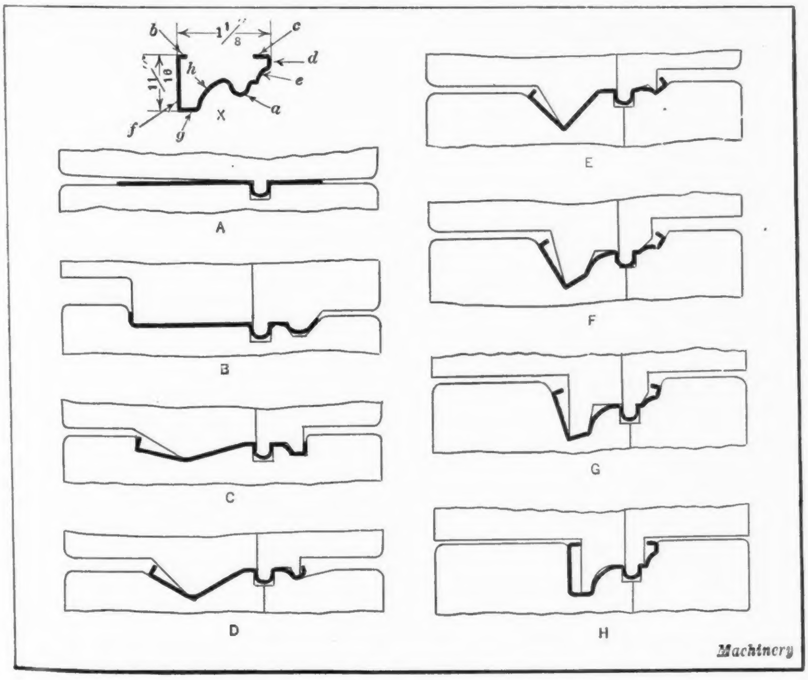


Fig. 6. Successive Steps in forming the Irregular Section illustrated at X

* * *

The tire manufacturing division of the Rubber Association of America, embracing about 75 per cent of the production capacity of the tire industry, has issued a bulletin of great interest to all automobile and truck owners. The object of the bulletin, which is entitled "Tire Tips," is to advise users on the care of tires with the view of increasing the tire life, because of existing high prices. The association's address is 250 W. 57th St., New York City.

Welding Aluminum Alloy Castings

By A. EYLES*

DURING the last few years much progress has been made in the art of repairing fractured and defective castings made of aluminum and aluminum alloys. The experience of the writer in the fabrication of aluminum by autogenous welding and other methods of joining parts made of this metal has been very extensive, but as it has been mostly on repair work, the present article is written especially for those engaged in this field. However, many of the methods described are also applicable to production work.

The modern method of autogenous welding with the oxy-acetylene torch provides a means of making permanent repairs on aluminum and aluminum alloy castings that would have been impossible with the equipment available only a few years ago. In fact, this process is now recognized in the automotive and general engineering industries as a reliable method of obtaining permanent and homogeneous welds in such materials. Many production problems have already been solved by employing this process for uniting aluminum or aluminum alloy parts.

A. Eyles

For permanent joints in automotive and machinery castings made of aluminum or aluminum alloys, the writer believes that welding by oxy-acetylene is decidedly preferable to any other method. The remarkable examples of repairs and reinforcements made on fractured, defective, or weak parts by careful oxy-acetylene welding must be examined to be appreciated. It may be truthfully said that practically nothing in aluminum alloy casting repair work is beyond the scope of modern oxy-acetylene welding practice, provided the work is done by experts equipped with the correct welding materials and equipment.

Although progress in the autogenous welding of aluminum was necessarily retarded by secrecy ten to twenty years ago, there is little in the process today that is kept secret. Skill and a knowledge of the latest developments in the art are necessary, however. The successful welding of aluminum alloy castings depends a great deal upon the success achieved in breaking down the aluminum oxide, the forming of which is intensified as soon as the oxy-acetylene torch flame comes in contact with the metal. It is this oxide film that prevents the proper flow of the metal at the welding temperatures and that has been the cause of many failures in aluminum welds.

Preparing Surfaces for Welding

In preparing fractured or defective aluminum alloy castings that are to be repaired by oxy-acetylene welding, it is first necessary that the surfaces to be joined be thoroughly cleaned. It is also essential that the material near the surfaces to be welded be also clean, as otherwise the impurities near the joint invariably set up auto-corrosion in the weld. The extra time taken in making sure that the aluminum joint is thoroughly cleaned and that all foreign matter is removed is well spent. An aluminum weld should be kept free from everything except the welding material and the flux. Any other substance or material will have an injurious effect on the weld.

Much of the dirt, oxide, etc., can be removed by a stiff steel wire brush and by scraping with old files ground to a chisel edge. Oily machine parts or automobile castings should be allowed to remain for a few seconds in a hot caustic soda bath. A 10 per cent caustic soda solution is satisfactory for this purpose. After being removed from the hot bath, the castings should be thoroughly washed and scrubbed in plenty of clean hot water. In some instances, it is advisable first to wash the oily castings with gasoline or benzine in order to remove the greater part of the grease and dirt. It may be necessary in some cases to heat the casting slowly with an atmospheric gas blow-pipe or a kerosene blow-torch flame until the oily matter contained in the pores of the casting has been expelled.

When autogenous welding is performed on castings that have not been thoroughly cleaned, the oil carbonizes and adheres to the edges of the metal, thus preventing the surfaces from being joined. After the work is cleaned, a V-shaped groove is filed or chipped along the crack or seam that is to be welded. The width of the V-groove should be at least as great as the thickness of the casting, the edges being beveled to the bottom of the pieces in order to permit the metal to be melted the full depth of the work. However, aluminum alloy castings up to 1/4 inch in thickness can be welded with the torch flame without beveling the joints. In making a weld on work of this kind, the operator employs a puddling rod made from a piece of mild steel rod 3/16 or 1/4 inch in diameter, which is flattened on one end like a flat scraper and bent at the other end to form a suitable handle.

The puddling rod is used to scrape and agitate the metal at the moment of melting in order to break up the oxide and allow the molten metal to flow together. The "puddling" method has an advantage in that a triangular groove is not required. It is necessary to wipe the puddling rod frequently to prevent it from becoming coated with oxide, and care must be taken not to allow it to reach a red heat, as otherwise oxide of iron will be formed on it which might result in a defective weld. Although more or less oxide will be embedded in welds made in this manner, the joint will be strong enough to meet most requirements. Tests made by the writer to determine the strength of welds made by the "puddling" method have often proved that the weld is stronger than the surrounding metal.

Welding Fluxes

The oxide formed in the course of melting aluminum offers considerable resistance to the welding flame, and as it does not always rise to the surface, especially if the work is thick, it must be eliminated to effect a homogeneous weld.

*A. EYLES was born in Cirencester, Gloucestershire, England, in 1873. He received his elementary education in the public schools, and served an apprenticeship with H. Tovey & Son, general engineers. He was later employed by the Great Western Railway Co. at their locomotive building shops at Swindon, and by M. Duffield & Son, Slough, heating and ventilating engineers. He obtained his mechanical education as a student at the Manchester College of Technology and through the International School of Correspondence of Scranton, Pa. For the last twenty-three years, he has been with the Lancashire & Yorkshire Railway Co., the London & North Western Railway Co., and the London, Midland & Scottish Railway Co., as foreman of the sheet-metal working departments. He has had considerable experience in experimental work. His specialty is aluminum fabrication and autogenous welding of sheet metals. He was the chief contributor to *The Practical Metal Worker* on soldering, brazing, and welding, and co-author of a book "Oxy-acetylene Welding" published by Cassell & Co., Ltd., London. He has been a frequent contributor to the technical press, and his contribution to MACHINERY on soldering and brazing of aluminum, published in December, 1914, has been included by the Bureau of Standards in its bibliography Circular No. 78 on "Solders for Aluminum."

This is best done by employing a flux which dissolves and deoxidizes the layer of oxide adjacent to the joint to be welded, at the temperature at which the aluminum reaches a molten state. Another function of the flux is to protect the fused metal from contact with the air. There are many so-called "welding fluxes," but for successful aluminum welding it is essential that a suitable flux be used. A satisfactory flux can generally be obtained from any reliable firm handling oxy-acetylene welding apparatus.

Aluminum welding fluxes prepared by oxy-acetylene welding operators are seldom economical or satisfactory. A welder rarely has the necessary apparatus for compounding the materials in the correct proportions, nor a sufficient knowledge of chemistry to be able to produce a satisfactory flux for aluminum welding. He is also handicapped by lack of experience in buying chemicals of the quality required. For these reasons, the writer would advise buying the welding flux from some firm that has established a good reputation on the merits of its products.

Welding fluxes consisting of various combinations of alkaline chlorides, fluorides, and sulphates are now employed on aluminum castings with excellent results. An example of a good flux for aluminum and aluminum alloys with a melting point of approximately 1110 degrees F. is one containing a mixture of lithium chloride, potassium chloride, potassium bisulphate, and potassium fluoride. The reactions that take place in the application of the flux are believed to be as follows: The potassium fluoride reacts with the potassium hydrogen sulphate, forming hydrofluoric acid, and this immediately acts on the aluminum oxide, forming aluminum fluoride, which is free to combine with the excess of potassium fluoride existing in the flux, forming potassium aluminum fluoride which is capable of dissolving a further quantity of aluminum oxide. The lithium chloride and potassium chloride serve the purpose of lowering the fusion point of the mixture.

FLUXES FOR ALUMINUM WELDING
(Figures in table represent percentages)

Sodium Chloride	Potassium Chloride	Lithium Chloride	Sodium Fluoride	Potassium Fluoride	Sodium Bisulphate	Potassium Bisulphate	Sodium Sulphate	Potassium Sulphate	Cryolite (Aluminum Sodium Fluoride)	Borax	Sodium Carbonate	Potassium Bromide
30.0	45.0	15.0	—	7.0	—	3.0	—	—	—	—	—	—
30.0	45.0	15.0	—	7.0	3.0	—	—	—	—	—	—	—
—	33.4	33.3	33.3	—	—	—	—	—	—	—	—	—
12.5	62.7	20.8	—	—	—	4.0	—	—	—	—	—	—
16.0	79.0	—	—	—	—	—	—	5.0	—	—	—	—
17.0	83.0	—	—	—	—	—	—	—	—	—	—	—
6.5	56.0	23.5	—	—	—	—	4.0	—	10.0	—	—	—
86.0	—	—	—	—	—	—	14.0	—	—	—	—	—
16.36	—	—	—	—	—	—	3.63	—	—	70.0	10.01	—
90.0	1.0	—	—	—	—	—	9.0	—	—	—	—	—
14.5	—	—	—	—	—	—	70.0	—	—	11.7	3.5	—
30.0	40.0	10.0	10.0	—	—	—	—	—	—	—	—	10.0
79.2	4.2	7.4	—	—	—	—	—	—	9.2	—	—	—
12.0	60.0	24.0	—	—	—	4.0	—	—	—	—	—	—
15.0	80.0	—	—	—	—	—	—	5.0	—	—	—	—

Machinery

Another view is that the potassium bisulphate may act partially alone, for on heating this salt to a temperature higher than its melting point, it forms potassium pyrosulphate, and on further heating breaks up into potassium sulphate and sulphur trioxide. As this chemical change takes place at about 1110 degrees F., it can be readily understood how the bisulphate will decompose substances like cryolite and calcium fluoride at a lower temperature than that required to fuse the mineral or salt itself.

Aluminum and most aluminum alloys melt very slowly, because of their high specific and latent heat. When castings that have sand on their surface are to be welded, a flux that will remove the sand must be used. If the sand is not removed, it is in part reduced, resulting in silicon being passed into the metal—a condition that often reduces the strength of the weld an appreciable amount. A flux that is adapted for use under these conditions is composed of potassium chloride or fluorspar. This flux will prevent silicon from entering the alloy.

The melting points, expressed in degrees F., and the ingredients mostly used in the manufacture of aluminum welding fluxes are approximately as follows: Potassium chloride, 1350 degrees F.; sodium chloride, 1420 degrees F.; lithium chloride, 1110 degrees F.; potassium fluoride, 1455 degrees F.; sodium fluoride, 1650 degrees F.; potassium bromide, 1300 degrees F.; and cryolite, 1755 degrees F. The accompanying table gives the compositions of several fluxes commonly used for welding aluminum or aluminum alloys, but most of these are patented compounds.

Method of Applying Flux

There are various methods of applying the flux when making a weld. The flux may be applied in paste form to the surfaces to be welded, or the parts may be heated and the powdered flux sprinkled over the joint, or the end of the welding rod may be heated and dipped into the flux, which readily adheres to it in the form of a thin varnish; the last method is the safest and best. It should be unnecessary to apply more flux to the weld than that which coats or varnishes the rod. Fluxes for aluminum welding are usually in the form of a very fine powder, and can be readily employed as described. The powdered fluxes should be kept free from dust and dirt, and preferably in air-tight containers, as they absorb moisture rapidly, which causes them to deteriorate. Aluminum welding fluxes, when obtained from the manufacturer, are put up in bottles that are tightly corked and sealed with wax.

Welding Material

The welding material—usually in the form of a rod—for broken aluminum parts, should be of as pure aluminum as it is possible to obtain. For aluminum alloy castings, the welding material should be of approximately the same composition as the alloy to be welded, in order to produce a uniform joint. When a pure aluminum rod is used in welding an aluminum alloy casting, the weld will be somewhat softer and more flexible than the rest of the casting. This condition is, of course, undesirable, especially in the case of machine and automobile castings where the parts are subjected to excessive vibration, stress, shock, etc. Aluminum alloy rods for welding aluminum alloy castings are obtainable from the manufacturers of oxy-acetylene welding apparatus. The minimum size of rod commonly used is about 3/32 inch in diameter, while even for very thick work, rods over 5/16 inch in diameter are seldom used.

Preheating the Work

In welding aluminum and aluminum alloy castings, it is necessary to preheat and anneal the work in order to prevent too rapid expansion and contraction of the metal. Preheating is also advantageous in that it conserves gas, increases the rate of welding, and prevents warping. Great care, however, must be exercised to avoid exceeding a temperature of 750 and 840 degrees F., respectively, when preheating and reheating or annealing the work. At higher temperatures than these, aluminum alloy castings become very fragile, and a piece of work that may be quite good so far as the weld is concerned may be rendered useless by the deformation it undergoes during the welding process.

The workman can generally tell when the proper preheating temperature has been reached by rapping the casting. A cold aluminum casting will give forth a metallic sound when struck, but as it becomes hot, the metallic sound grows less and less perceptible, and when the safe preheating temperature has been reached or exceeded, it will no longer resound when struck. Another method of determining the correct temperature is to apply a pine stick to the casting. At the time the correct temperature has been attained, the cast-

ing will slightly char the pine stick when it is brought into contact with the metal.

In the case of castings of complex shape or castings that vary greatly in thickness, it is advisable to support the work beneath the sections or joints to be welded with iron or steel sheets, bent to fit the casting and covered with sheet asbestos. The sheet metal, in turn, may be blocked up with firebrick to provide the required support when the metal is hot. During the preheating process, the casting should be covered with sheet asbestos to keep the temperature as uniform as possible. The asbestos should not be removed during the welding operation, except as it is necessary to effect the weld.

Many aluminum parts can be welded successfully without preheating, as, for instance, small pieces or lugs that have been broken off at a point some distance from the main part of the casting.

Making the Weld

In making a weld, careful regulation of the torch flame is essential, and the metal should be heated slowly if the work is of such a nature that unequal expansion is likely to be harmful. The torch flame should be so adjusted that it will furnish a slight excess of acetylene, and it should be kept further from the metal than is the usual practice in welding iron or steel. It is essential to avoid contact of the white-hot bulb or cone with the metal that is about to become molten, because the hot temperature in this part of the flame tends to produce holes in the metal which are often difficult to repair, particularly in the case of thin sections. The correct distance of the tip of the white bulb or cone part of the flame from the metal varies according to the size of torch tip employed. In general, the distance should be from 1/4 to 3/4 inch. The end of the welding rod should be kept in the molten bath while welding. The puddling of the metal during the welding operation is necessary in order to insure proper alloying or mixing of the metal.

After welding, the casting should be reheated evenly and allowed to cool very slowly. In no case should it be hammered while cooling. When the casting is cold, it should be thoroughly washed in hot water to remove all traces of the flux, which would otherwise continue to produce a chemical action on the metal that would result in harmful corrosion. If necessary, the surplus metal at the weld may be removed by machining and the machined surfaces restored. If the weld is properly made in an aluminum or an aluminum alloy casting, the actual weld may be nearly as strong as the casting itself, and by judicious reinforcing or "building up," the welded joint is in many cases actually stronger than the original metal. Many aluminum machine and automobile castings repaired by experienced welders have withstood years of service.

* * *

POINTS ON ASSEMBLING MACHINES

By S. W. BROWN

In the production of machines in large quantities, the assembling operations are usually easily accomplished because the difficult preliminary work is done in the early stages. The drawings have been corrected so that the units made from them can be assembled with less hand fitting. The wooden patterns have been replaced by metal ones, and special tools have been made, not only to manufacture the parts accurately, but also to assist in assembling them. Then, too, the workmen engaged in assembling the parts have acquired skill and dexterity by doing one series of operations repeatedly.

The assembling of one or a small lot of machines for the first time is an entirely different matter; such work requires considerable ingenuity, as it means not only the accomplishment of the work at hand, but preparation for future lots—this, too, without previous experience on the same machine and without knowing whether or not the machine will work when completed.

Let us assume, for example, that the problem is to assemble one machine of medium size that consists mainly of a base member having sections of mechanism attached to both its upper and under surfaces and that the whole assembly is supported by four feet. This construction is selected for the problem because it is common to many types of machines. The successful assembling of such a machine depends so much upon the methods employed in making the units of the machine that a few comments concerning this part of the work are desirable.

In modern practice, machine parts are made by working to detail drawings. These drawings are meant to be, and generally are, correct. Notwithstanding this fact, it is common practice, in making parts for a new machine, to leave stock for fitting on nearly all the parts, and to omit drilling certain holes, such as screw-holes, in the larger parts. This practice serves no good purpose. It is really a method handed down from former times when machinery was built by the cut-and-try method.

It is true that certain parts of a new machine should not be completed until their assembly, as for example, the length of bevel gear hubs, holes that are to be line-reamed, dowel-holes in the base member, and pin-holes in some cases. However, with a few exceptions such as mentioned, good results may be obtained by completing the parts as nearly as possible to the specifications on the drawings.

It is a good plan to machine two adjacent edges of the base member for convenience in locating sections on the base surfaces by measuring from the finished edges. Horizontal and vertical center lines scribed on the base surfaces are also of assistance in locating the sections. Assuming that we have a lot of parts ready to assemble that are made in accordance with the foregoing suggestion, the first step is to place the upper surface of the base member on a surface plate. If a large enough plate is not available, the base may be placed on wooden blocks, but in the latter case it should be leveled up, as the weight of a heavy base resting on blocks may cause it to spring. Next the sections may be located on the base surface. These should be first screwed on, then set accurately, and doweled in position. After locating all sections, including the feet, the partly assembled machine should be turned over so that it rests on its feet, after which the base should be leveled. This may be done by inserting pieces of shingles between the feet and floor.

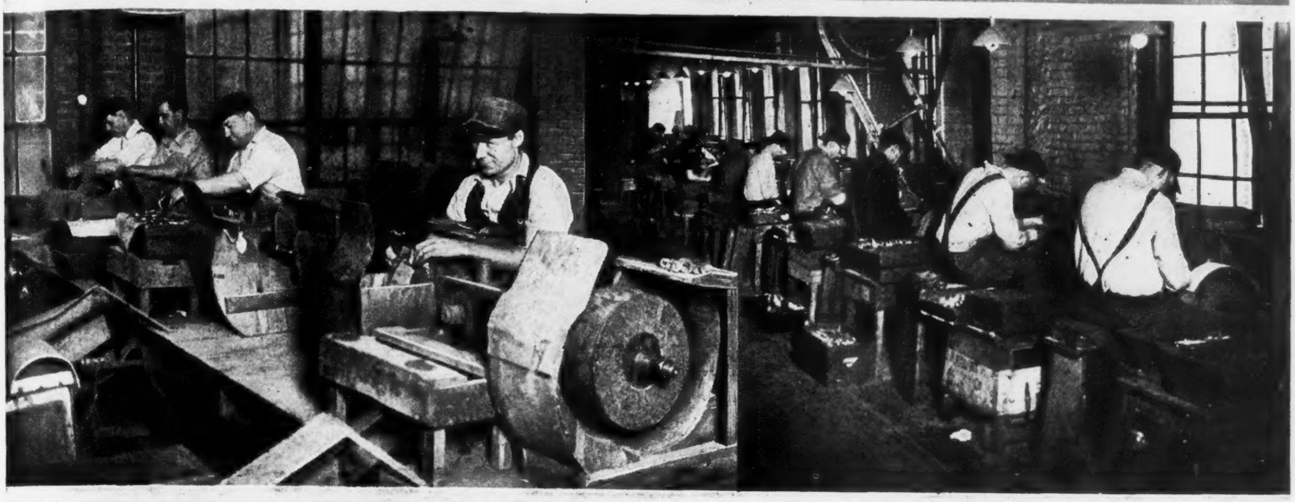
In this position, the machine may be completed by locating the sections as previously explained. The sections of the mechanism are assembled, as far as possible, previous to the general assembly here considered. Neatness of workmanship is important in both sectional and general assembling. A little dirt or a burr or two may alter the location of parts several thousandths of an inch. The exterior of a machine should be made to present a neat appearance. Sharp corners and unsightly lumps on castings should be eliminated.

It is very important to make ample provision for oiling a machine. All oil-holes should be in plain sight. Tubes may be used to convey oil to remote bearings. In most cases oil-holes should be fitted with some sort of oiler provided with a cover to keep out dirt. In assembling a machine, a record should be kept of all errors found on drawings and patterns and also of any changes made.

* * *

TREMENDOUS RISE IN RADIO BUSINESS

Radio has climbed in a little more than five years from a hobby of a few scientists to a business in 1925 of more than $500,000,000—a growth almost unparalleled in American history. Manufacturers' estimates for 1925 indicate a sale of 3,000,000 radio sets and 20,000,000 tubes. The year's volume of radio business will exceed last year's by $200,000,000. Besides the completed sets, sales of $150,000,000 in parts and accessories indicate a considerable volume of homemade sets. The industry now employs about 300,000 persons in the 1200 plants, and 40,000 dealers' stores, nearly all of which have come into existence in the last five years.



Metal Polishing by Modern Methods

A NUMBER of objects, many of which may be advantageously finished by the use of specially formed polishing wheels, are shown in Fig. 1, and recommendations for polishing these will be given in the following. The sewing machine arm *A* is an iron casting, which should first be roughed all over with a compress leather or canvas wheel of medium density, 14 inches in diameter having a cushion 2 inches deep. This is a flexible grinding operation for which No. 46 alundum will give satisfactory results. After the scale has been removed from the casting in this way, the surface is finished in three polishing operations—roughing, dry-fining, and greasing.

For polishing the horizontal over-arm, a compress canvas wheel of medium density is recommended, having a diameter of 15 inches, a face width of 2 inches, a 2-inch cushion, and rounded corners. These wheels should be set up with a rolled head, using No. 46 abrasive for roughing, No. 80 for dry-fining, and No. 120 for greasing. In the greasing operation, the wheel is treated with cut cake. An average peripheral speed of 7500 feet per minute is suitable. For working around the upright part of the casting, a muslin wheel made from hand-sewed or quilted buffs, 16 inches in diameter and 3 inches wide, should be employed. This operation is illustrated in Fig. 2, which shows how the wheel should be formed for working around these curved surfaces. For the head end of the casting, a wheel of the same type, but having a width of only 1 1/2 inches, can be used to advantage. The same grit abrasive as mentioned previously should be used for setting up the muslin wheels for each operation.

Polishing a Handle-bar Brace and Post

The baby carriage handle-bar brace shown at *B*, Fig. 1, is made from steel tubing and subsequently copper-plated. It should be polished in three operations—roughing, greasing, and coloring—for all of which a compress canvas wheel of soft density is suitable. The wheel is set up by rolling, and the abrasives are No. 120 alundum for roughing and No. 150 for both greasing and coloring. Emery cake is used for coloring, and the wheel is stoned and treated with soft charcoal.

The forms of wheel faces necessary for working all surfaces of this part are shown in Fig. 3 at *A*, *B*, and *C*. Wheel *A* is 12 inches in diameter and has a 3 1/2-inch face, which is formed as shown in order to polish two pieces at a time. Wheel *B* is used for polishing the inside of the elbow; it has a 1 1/2-inch face and is also 12 inches in diameter. The shape of the wheel used for finishing the exterior curved portions is illustrated at *C*, this wheel being only slightly concave on the face. It is also 12 inches in diameter.

The handle-bar post for a bicycle is shown at *E*, Fig. 1, this part being a steel casting, nickel-plated. Four operations complete the polishing work before plating, these being roughing, dry-fining, greasing, and coloring. All polishing may be done on a compress canvas wheel of soft density, the abrasives being No. 46 alundum for roughing, No. 80 for dry-fining, No. 120 for greasing, and No. 150 for coloring. An average surface speed of 7500 feet per minute is recommended.

For the straight part of this post, a straight-face wheel 2 inches wide, having a 3-inch cushion, may be used. The hub can be readily polished with a straight-face wheel of soft density having a deep cushion which will contact with the irregular surfaces at this end of the work. For working around the inner angle of this part, a wheel shaped as shown at *D*, Fig. 3, should be used. This wheel is 15 inches in diameter, 1 inch wide, and has a 3-inch cushion of soft density. By turning the part back and forth, the curved surfaces may be nicely blended. After polishing as described, the parts are nickel-plated and buffed.

Polishing Circular Grooves

The design of compress polishing wheel shown at *E*, Fig. 3, is a common construction for polishing the grooves in cast-iron sheaves. This general shape and design would also be suitable for polishing around the neck of the pipe fitting shown at *G*, Fig. 1. This wheel shape and the abrasives and operations for polishing the pipe fitting are practically the same as those for polishing the necks of the brass faucet part *K*, which will be described later.

Cast-iron sheaves are polished in three operations, using a compress canvas wheel 24 inches in diameter and 1 1/2 inches wide. The wheel shown has a 3-inch cushion of extra soft density, and is provided for each operation with a rolled head of abrasive of the following grits: No. 46 alundum for roughing; No. 80, for dry-fining; and No. 120 for greasing, using cut cake for the last operation. The sheaves should preferably be sand-blasted and should have a fairly smooth surface when ready for finishing, so that the roughing or flexible grinding operation may supplant the use of a solid grinding wheel for finishing the sheave groove.

Wheels and Operations for Polishing Wrenches and Screwdrivers

Pipe wrenches and certain grades of screwdrivers can be polished by using a flat wheel and employing only two operations. The steel forgings *D*, Fig. 1, are the outer and inner jaw members of a pipe wrench which may be handled in this way. This kind of work is usually roughed with No. 60

abrasive and finished with No. 120, no grease being used unless a higher finish than usual is required, in which case an additional polishing wheel is employed and grease is used.

Screwdrivers may be polished by the use of formed-face wheels, and three shapes for this general purpose are illustrated in Fig. 4. Wheels *A* and *C* are formed with multiple grooves to fit both large and small screwdriver handles. These wheels, as well as wheel *B*, are each 14 inches in diameter, with a 3-inch face and a 2-inch cushion. They are made of compress canvas. The two wheels shown in the lower right-hand corner at *D* are especially formed on the face to finish the curved surfaces of steel safe handles. These are made of compress canvas of medium density, have a 2-inch depth of cushion, and 1 1/2-inch face.

Examples of Brass Finishing

The fire extinguisher handle *H*, Fig. 1, is a brass casting and is polished on wheels having specially formed faces, as shown at *A*, Fig. 5. Two operations are required to polish each surface of these handles, and three styles of wheels are employed. For the body of the handle, a flat-faced wheel is used. For the under side of the handle, a wheel of the type shown at the left is most efficient, while for the top of the handle, a wide-face wheel, formed in the manner indicated to the right, may be employed. These wheels are made of compress canvas, and are 14 inches in diameter, with a 2-inch cushion; for both operations, they carry a rolled head of No. 120 alundum.

The wheels for the under side of the handle should be about 1 1/2 inches wide and of soft density; those for the top of the handle are 3 1/2 inches wide and of extra hard density. The flat-face wheel for the body of the handle requires a medium density cushion and rounded corners, and should be about 1 inch wide. The contours that may be polished at one time by the use of a polishing wheel designed for curved surfaces are well illustrated in this case, and the advantages of such wheels for work of this kind are apparent.

The glass door knob *I*, Fig. 1, has a brass ferrule which is polished by the use of formed-face polishing wheels that finish the entire ferrule. This wheel is shown at *B*, Fig. 5, and two of these wheels are used to finish the door knob, one for roughing and one for greasing. The wheels recommended are made of compress canvas, 14 inches in diameter, 2 inches wide, with a 2-inch cushion of medium density, each set up with a rolled head of No. 120 abrasive. These door knob ferrules are not plated, but are cut down on a stitched buff using tripoli brick as an abrasive, and finish-buffed, or colored, on loose open buffs, using a compound of Vienna lime, wax, and grease which is made in cake form under the trade name of "White Diamond."

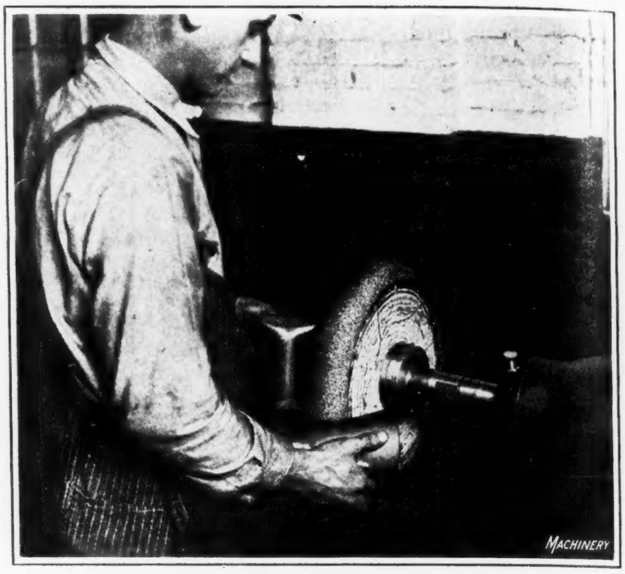


Fig. 2. A Formed-face Quilted Polishing Wheel used for polishing the Upright Part of a Sewing Machine Arm

Cast-iron Handles and Wheels

Machine handles such as shown at *L*, Fig. 1, and similar cast-iron machine units, including handwheels, etc., are advantageously finished by polishing on compress wheels set up with a formed face of abrasive and glue. The diagrams at *C* and *D*, Fig. 5, illustrate the shape of wheel-head regularly employed for handling work of this kind. Two operations only are required, the roughing wheel being of medium-hard density canvas, and the finishing wheel of soft density canvas. These wheels should be 12 inches in diameter, with a 3-inch face and a 2-inch cushion. They should be run at a speed of 7000 feet per minute, and should be set up with a glue head by the paste process, using a templet to produce the proper contour. The abrasives used are Nos. 60 and 120.

In polishing cast-iron handwheels, the polishing wheel may be set up either by rolling or with a paste head. If rolled, two coats of abrasive and glue should be used. The wheel is 16 inches in diameter, with a 2-inch face and a 2-inch cushion made of medium density compress canvas. The degree of finish required determines the number of operations necessary, but usually two are sufficient, although sometimes three are used. The proper grain sizes for the abrasives are No. 60 for roughing and No. 120 for dry-fining. If a third wheel is used, the handwheels would be finished with a greased wheel set up with No. 150 abrasive. This wheel should be stoned to break down the cutting edges of the abrasive. During the finishing operation, the wheel is fed with cut cake, and soft charcoal is used from time to time. Often special swinging holding devices, suitably counterbalanced, are used for polishing handwheels, the work being held on an arbor while the device is being manipulated by the operator.

Finishing Turbine Buckets

The two styles of polishing wheels shown at *E*, Fig. 5, are used for polishing the inside and outside surfaces of buckets for turbines. The use of a compress polishing wheel for performing flexible grinding operations is well illustrated in the finishing of these turbine buckets. A flexible grinding wheel was employed for this purpose after failing to obtain and maintain the correct shape with solid grinding wheels.

Four operations are required to finish these parts, flexible grinding, roughing or dry-fin-

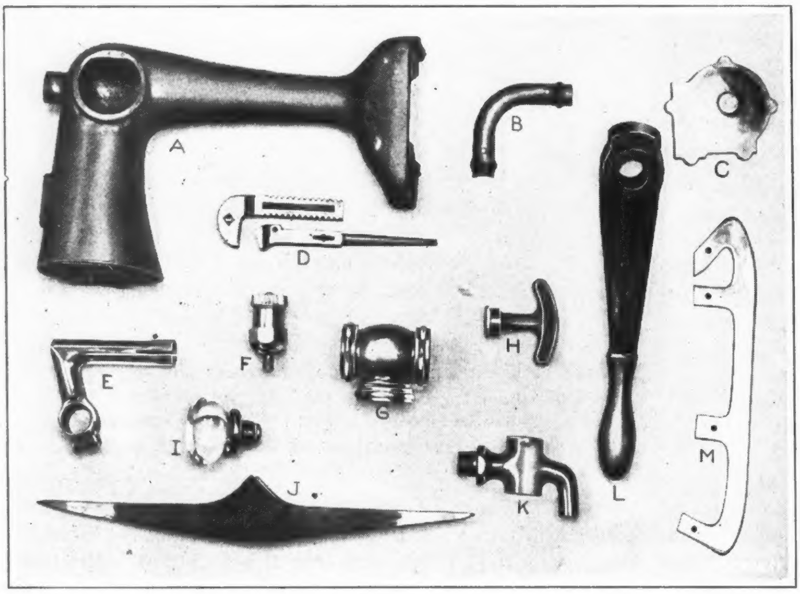


Fig. 1. Articles of Various Materials finished by flexible-grinding and polishing

ing, greasing, and coloring. The buckets are 0.40 per cent carbon steel forgings. For this work, a compress canvas wheel of medium density has been found suitable. These wheels are 14 inches in diameter, 2 inches wide, have a 2-inch cushion, and are set up with a rolled head. For the flexible grinding operation, No. 46 alundum is used; for the dry-fining, No. 80; for greasing, No. 120; and for coloring, No. 150 with any desired coloring cake. Speeds of from 7000 to 7500 surface feet per minute are suitable.

Finishing Operations for Brass Bibs

The polishing operations on brass faucet parts of the type shown at *K*, Fig. 1, fall into a general class by themselves. These brass castings are finished in two polishing operations and a buffing operation. They are roughed with No. 60 alundum and finished with No. 120; the head of glue and abrasive is applied with a brush—that is, instead of setting up the wheel with a paste head, the alundum is mixed with the glue and applied with a brush. Compress canvas wheels of soft density are suitable for both the roughing and finishing operations on these parts. For the body of the casting, a 1 1/2-inch flat-face wheel should be used; a 3/4-inch radius-crowned wheel is used for the large neck, and a 1/2-inch radius-crowned wheel for the small neck.

For the finishing operation, the wheel should be lubricated or greased with tallow and emery, and after polishing, the work is buffed. In buffing, tripoli cake is used for cutting down on a wheel of 1-inch face width, made of sewed buffs. The coloring operation is done on an unbleached cotton loose buff, using 4X "White Diamond" buffing composition. If the castings are to be plated, which is sometimes done, they are afterward buffed with the kind of coloring buff and composition just mentioned.

Flexible Grinding Operations

Implements such as picks, axes, and agricultural hand tools, are ground at the working point or blade, and for this work, flexible polishing wheels are well adapted. By means of flexible grinding, the subsequent finishing by polishing is considerably lessened.

The pick shown at *J*, Fig. 1, is a rough forging, and is ground on the points for a distance of 2 or 3 inches. If care is taken, in forging these picks, to wire-brush the surfaces between operations and thereby prevent the accumulation of large amounts of oxide scale, it will be found that the surfaces will be in such condition that they may be roughed directly on a flexible grinding wheel. However, it is often necessary to point these picks on a solid grinding wheel to remove this scale. For flexible grinding, a compress canvas

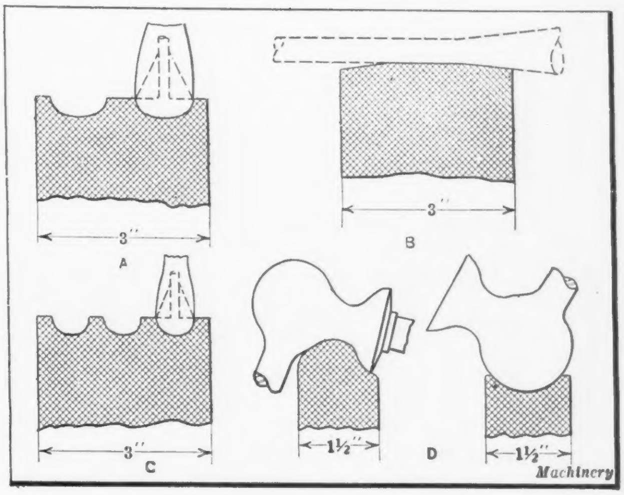


Fig. 4. Other Examples of Formed-face Polishing Wheels

or leather wheel of hard density is recommended, it being necessary for the wheel to be hard in order to keep the edges square. The use of a soft wheel would result in rounding the edges, which is undesirable. This job is completed in one operation, the wheel being set up with No. 60 alundum.

The pick comes under the general classification of the axe and similar tools that may sometimes require a higher finish than is possible in one operation, in which case the surfaces may be further finished by using the same type of wheel, but grading the abrasive so that each successive operation will be performed with a grit about forty numbers finer than the previous one. The flexible grinding of grub-hoe heads is illustrated in Fig. 7, in which a compress polishing wheel is shown in use.

The skate blade *M*, Fig. 1, is another good example of flexible grinding. These blades are stamped out of sheet steel, and the burr produced on one side by the dies must be removed if a solid grinding wheel is to be used for surfacing, as otherwise an even seating on the magnetic chuck cannot be obtained. When a compress polishing wheel is used, this operation is necessary, because the construction of the wheel permits it to follow the rough surface of the work without being held rigidly in one working plane.

This particular job was formerly punched out at one end from one side, and at the other end from the opposite side, so that there were burrs on both sides. By giving attention to the method of producing these blades, much work could have been eliminated. The only change necessary when flexible wheels were adopted was in the design of the dies, so as to make it possible to stamp the blade at one stroke of the press, thus producing all the burrs on one side.

The operations required to finish this skate blade before nickel-plating are four in number, and consist of flexible grinding, roughing or dry-fining, greasing, and finishing or coloring. The wheels used are made of compress leather, medium density, and have a 2-inch cushion set up with a rolled head. For the flexible grinding No. 60 alundum is used; for dry-fining, No. 120; for greasing, No. 150; and for finishing or coloring, No. 150.

The type of finish on chisels, hammers, and other unplated but highly polished builders' hardware requires about the same kinds of abrasives and general procedure as for skate blades before plating. It is sometimes the practice to color such work without the use of a composition cake, the coloring being produced by the use of crocus cake.

In finishing articles prior to plating, the wheel is evenly stoned, frequently treated with soft charcoal, and is fed with a cut cake

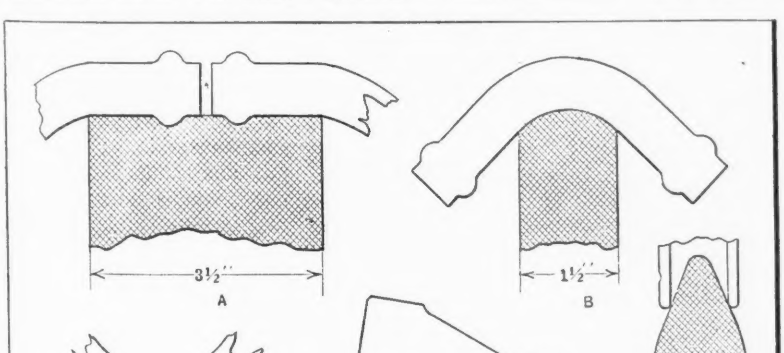


Fig. 3. Various Formed-face Polishing Wheels

consisting of beeswax, suet, and flour emery. For coloring, or more properly, "nickel buffing," skate blades and similar parts after plating, "White Diamond" is applied to the buff.

Polishing Aluminum Parts

There are two aluminum parts shown in Fig. 1—the bearing bracket for a magneto, shown at *C*, which is a sand casting, and the oil-cup *F*, which is a die-casting. The polishing methods by which these two parts are finished are as follows: For the sand casting, a greased wheel is used, and the abrasive is selected according to the quality of the surface of the work; one operation is sufficient, using No. 120 grit alundum. A compress canvas wheel of soft density is recommended. After polishing, a stitched buff is used with tripoli to cut down the surface, and then an open buff is employed with a composition of lime, wax, and grease to color the surface. The wheel speed for the greasing operation is 7000 feet per minute, and for buffing, from 8000 to 10,000 feet per minute.

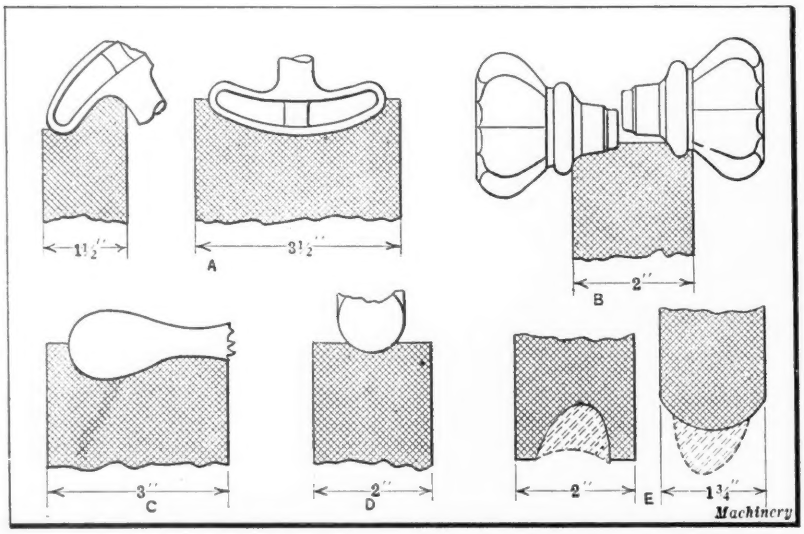


Fig. 5. Polishing Wheels of Special Shape designed for handling Fire Extinguisher Handles, Door Knobs, Machine Handles, and Turbine Buckets

The die-cast aluminum oil-cup *F* would be handled on a greased wheel using No. 150 alundum instead of the coarser abrasive used on the sand casting. This, of course, is on account of the better surface of the die-casting. The same type of wheel may be used, and the cutting down and coloring buffs would be the same as for the sand-cast part.

Special Devices for Polishing

The arrangement shown in Fig. 6 indicates how round stock and tubing can be handled, as, for example, when removing the flash at the weld on gas and electric welded iron pipe. A roller is provided, which is so arranged that the work is free to swivel. The pressure of this roll against the pipe is applied by a foot-pedal *B* so that, as the work is passed between the roll and the formed face of the wheel, a varying pressure can be applied, depending upon the quality of the surface of the pipe.

For work of this kind, a compress canvas wheel of soft density is suitable. The wheel should have a 2-inch cushion, and if made 14 inches in diameter, with a 2 1/2-inch face, will be about right for the average pipe sizes. By pulling the pipe through at an angle, the wheel can cut across the flash, and the contour of the wheel face is not destroyed, as it would be if the pipe traveled parallel with the side of the wheel.

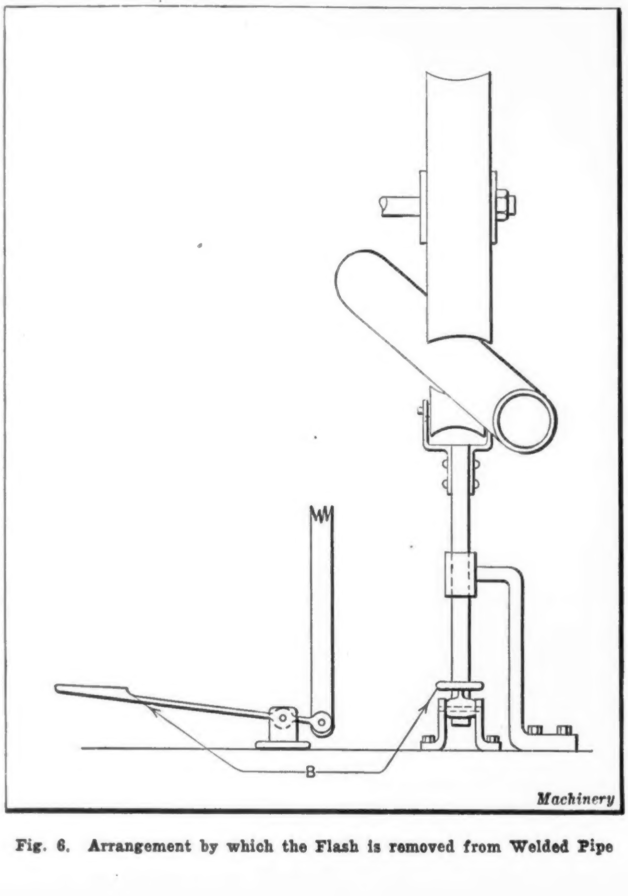


Fig. 6. Arrangement by which the Flash is removed from Welded Pipe

For rough work of this kind, No. 46 alundum is recommended; the wheel should be set up with a stiff mixture of glue and abrasive, using two coats of this paste. It is not necessary to use a templet to form the face of the wheel for work of this kind. This operation is distinctly a flexible grinding operation, and in order to keep the face of the wheel flexible, it is broken up by hitting it successive blows with a piece of pipe.

Handling Plow Bottoms

Plow bottoms and other agricultural implements are regularly finished by polishing or flexible grinding. For work such as this, a wheel having a comparatively soft face is required, as the wheel must spread in the course of the operation so as to cover the curvatures of the work. Among the various wheels that are suitable for this work is the solid canvas wheel, glued at the center but left open on the face. This wheel is supported by the use of side plates, but the face is free to follow the surface of the work. Muslin wheels are also used for this work, these being made of sewed buffs glued together to stiffen them and give the desired density. In the compress type of polishing wheel, a soft density cushion of bullneck or other leather is suitable. Wheels of this kind give general satisfaction for flexible grinding and polishing plow bottoms, provided the cushion is kept soft and pliable.

The peculiarity of shape of this work requires that special devices be provided for presenting the surface to the wheel. In Fig. 8, a swiveling fixture is shown in use for holding plow bottoms. By this arrangement, the operator can pass the surface of the work under the wheel. It will be noticed also that the polishing stand has a special hood through which the dust is removed by the exhaust system.

Polishing Flat Work and Saw Blades

Various kinds of saw blades require a high polish, which is produced by methods that are rather special, owing to the size of the work and the fact that the sides must be kept flat and the thickness uniform. Hand-saw blades, for example, may be held magnetically on a planer-type table, and passed back and forth under the wheel, the movement of the table being controlled by a foot-pedal.

Compress leather wheels are satisfactory for polishing saw blades, and the abrasive used is usually some grade of emery. Artificial abrasives are not recommended in this case, owing to the fact that they have a sharp, harsh cut. When artificial abrasives are used for high quality work, they must be properly set up on the wheel face and em-

bedded in the glue so that no sharp points project and produce deep scratches. The emery is not set up on the wheel face in the regular manner, but is fed loosely on the work, and a wide-face wheel soaked with oil is employed.

The method by which hacksaw blades are handled is as follows: These blades are passed over a paper-faced steel roller, supported by a stand directly under the polishing wheel. Compress leather wheels are also suitable for this work, and the abrasive is fed loosely on the work in the same way as when polishing hand-saw blades.

Circular saws may be mounted on the arbor of a motor supported on a standard, and while the saw is driven in this way, the surface of the work may be polished by using an abrasive stick, such as carborundum, and passing it across the side of the saw. The saw should be reinforced at the back by a steel disk or flange, so that the pressure exerted in polishing the opposite side will not cause it to spring. A floor-stand or support should be used, against which the abrasive stick may be laid while being passed back and forth over the revolving saw.

Polishing Flat Wire and Sheet Metal

When finishing flat steel wire, advantageous use may be made of polishing wheels by mounting a number of them in such a manner that the wire can be passed through from one coil at the rear and wound on another coil at the front. For this work, six canvas wheels, 10 inches in diameter, have been employed. These are mounted in pairs, the wheels staggered relative to each other, and after passing between these wheels, the wire is further finished by passing it between four sewed buffs, which are also staggered in pairs.

Another adaptation of polishing methods is the polishing of strip and sheet steel that is to be used for stamping work. This eliminates the expense of polishing large numbers of small stampings, which is a time-consuming operation and a more or less unsatisfactory one.

Fig. 7. Flexible Grinding of Grub-hoe Heads

* * *

GERMAN MACHINERY IMPORTS

During 1925 the tendency on the part of the German Government was to permit the importation of machinery more freely than at any time since the import restrictions took effect. This tendency was reflected in increasing imports. It is pointed out in *Commerce Report* that, during the first four months of 1925, Germany imported more than twice as much machinery as during the entire year of 1924. The importation of machinery, however, fell off shortly after August 1. The chief kinds of machinery imported into Germany are textile machinery, agricultural machinery, and metal-working machinery. The United States was the chief supplier of metal-working machinery.

THE EFFECT AND COST OF ZINC AND ALUMINUM ON DIE-CASTINGS

In a statement obtained from Charles Pack, vice-president of the Doehler Die-Casting Co., Brooklyn, N. Y., it is mentioned that about 90 per cent of all die-castings are produced from zinc or aluminum base alloys in which the zinc or aluminum, in turn, is over 90 per cent of the respective alloy metal. From this it follows that the price of zinc and aluminum is a highly important factor in the die-casting industry, since these two metals constitute at least 80 per cent of the raw materials in this industry. At the present time the die-casting industry is confronted by a serious difficulty in the form of high zinc and aluminum prices.

When die-castings take the place of cast-iron sand castings, they can do so only because they save in machining operations. In other words, the savings due to reduced machining operations must be greater than the additional cost of the metals used in die-castings.

To illustrate this point, let us assume that an engineer is considering the use of a zinc die-casting weighing 3 pounds, with the option of using cast iron, and the choice must be based on ultimate cost. The cast-iron casting would cost, say, 15 cents. With zinc at 6 cents, the value of the zinc in the casting would be 18 cents, and as the casting could not be machined for 3 cents, the die-casting is a good proposition. With zinc at 9 cents, the value of the zinc would be 27 cents. This means that in order to compete in the latter case, the die-casting process must show 12 cents per casting saving in machining cost. In actual practice, there are very few castings of that size that would cost 12 cents to machine, when produced in quantities. The result in a case of this kind would be the elimination of die-casting from consideration.

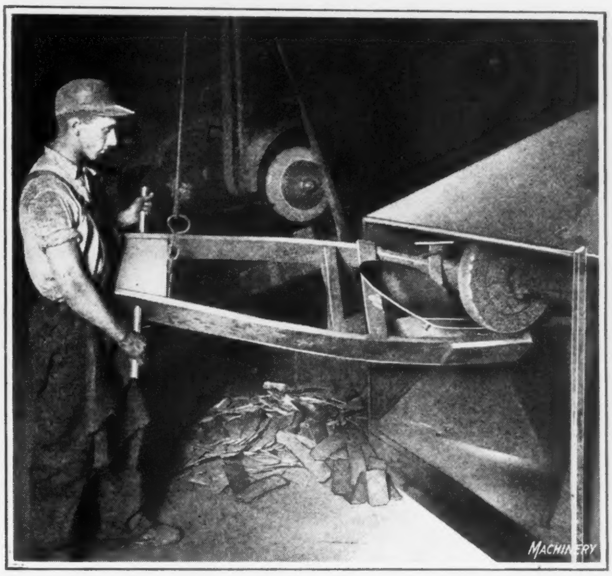


Fig. 8. Flexible Grinding of Plow Bottoms

The hypothetical case outlined actually represents the commercial status of the die-casting industry today. Whereas zinc could be bought at about 6 cents per pound, or less, two years ago, it is now selling at above 9 cents per pound. It is safe to say that as zinc increases one cent per pound in cost, the possible field of application for zinc-base die-castings is reduced by 15 per cent. The cost of raw materials in competing processes has not increased in the same proportion. Although cast iron fluctuates, it seldom fluctuates to the extent of one cent per pound, or $20 per ton.

Next to zinc, aluminum is the metal most vital to the success of the die-casting industry. Here the situation is just as difficult. Before the enactment of the new tariff law, ingot aluminum could be bought in this country and abroad for 18 cents per pound. Today, it is difficult to obtain at 28 cents per pound. On an aluminum casting weighing 3 pounds, the die-casting process must face a handicap of 30 cents greater cost.

Oil Piping System for Forge Shop

By C. C. HERMANN, President, Hermann Associates, Inc., Engineers, Rock Island, Ill.

IN designing a fuel oil distribution system for the furnaces of a forge shop, the routing of the work should receive careful consideration. Every effort should be made to have the work move along toward the point of final assembly without backward travel. To accomplish this, care must be taken in locating the furnaces. Generally it is not possible to handle all the work in a single furnace, and it is often necessary to have several furnaces with heating chambers of different designs. Some forgings require longer heats than others, some require protection from the flame, others may be heated in an open furnace, while still others require two or more heats of different temperatures. Thus it is obvious that variations in furnace design are necessary, and that furnaces must be located at different points in order to bring them in close proximity to the machines on which the forging operations are performed.

After planning the sequence of operations or the routing of the product and establishing the main lines of travel, the furnaces requiring the most oil may be given the best locations with respect to the main oil-pipe lines. The branch pipes leading to these furnaces should be made as short as possible. The plant expansion program for the next few years should also be considered. With this program in mind, the question should be asked: Where will future furnace installations be made and what will be the probable oil consumption? These questions are best taken up when planning the oil distribution system in order to obtain that desirable characteristic termed "flexibility."

Location of Oil-pipes

In Fig. 1 is shown the arrangement of a typical furnace and oil-pipe system for a forge shop. Before this shop was rearranged by the writer, the oil-pipe lines were located overhead. The building construction was of sawtooth design, and the oil-pipes were run near the roof. Considerable trouble was experienced during cold weather from thick oil, one-half to two hours' time being spent some mornings in getting the furnaces started. In redesigning, the oil-pipe system was removed from overhead and placed in concrete-lined trenches below the floor level. In Fig. 2 at *A* is shown a cross-section of the trench, which is 12 inches wide and 12 inches deep, with concrete walls and bottom. The walls and bottom are 4 inches thick and the trench is covered with cast-iron floor plates laid flush with the floor. These cast-iron plates have a bearing on the 1- by 1-inch T-irons secured to the concrete, as shown at *B*.

Referring again to Fig. 1, the storage tank is shown at *A*. The pump *B* removes the oil from the tank through the suction line *C*, and discharges it into the distribution line *D*. A by-pass *E* is used to connect the distribution line *D* with the tank in order to maintain a balanced pressure in the discharge line. A small heater tank *F* is used near the entrance to the forge shop to preheat the oil. This tank is provided with a steam coil *G* and is connected to a live steam pipe. The distribution pipe from the auxiliary tank to the furnace branches is shown at *H* and the return pipe at *J*. Various branch pipes such as shown at *K* lead from the main line to the oil burners. The entire piping system is paralleled by a steam pipe *L* which serves to keep the oil in a fluid state.

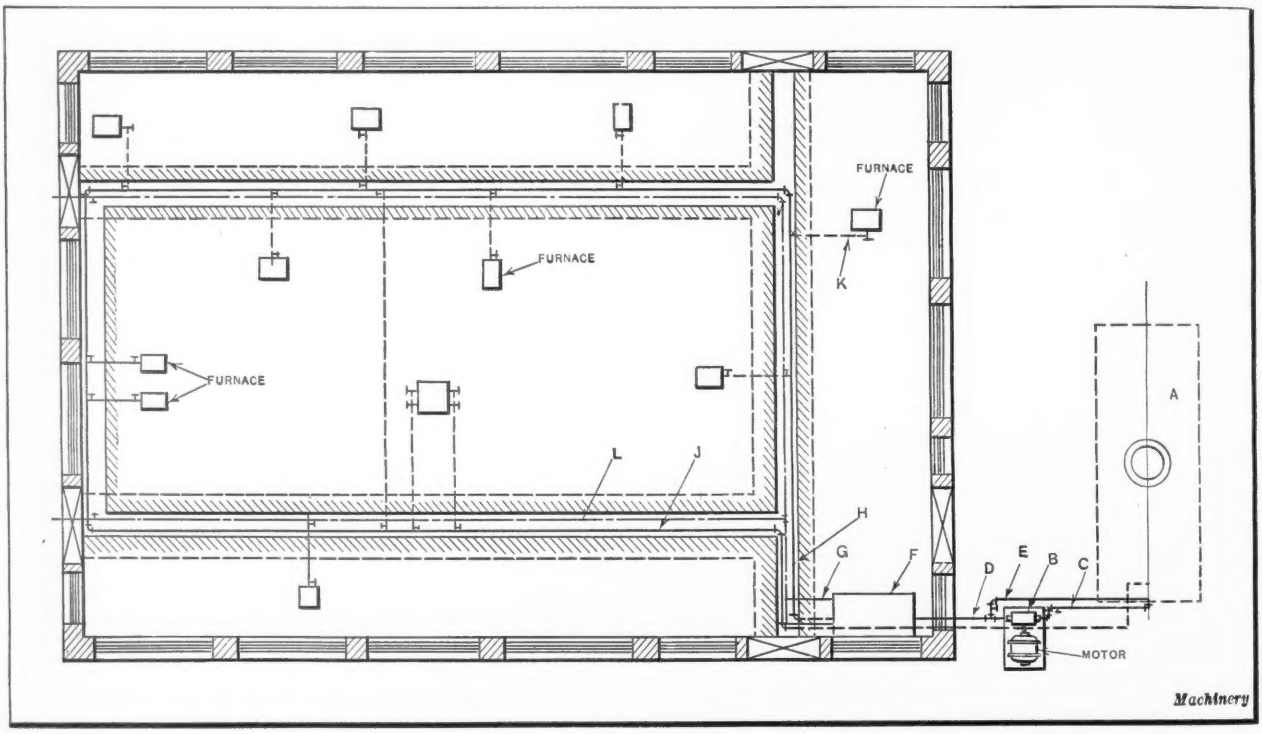


Fig. 1. Lay-out of Furnace and Fuel System for Forge Shop

Cleaning the Pipe System

Frequently it is found advantageous to pump the oil directly through the distribution piping in order to clean the pipes or to get rid of heavy oil, or water. This is accomplished by opening the valve on the return pipe at the tank and closing all burner valves. The oil is then pumped through the pipe *H* and back to the tank through the return pipe *J*. On very cold mornings the pump should be started earlier than usual and the oil pumped through the system until all the heavy oil has been removed. This saves time in getting the furnace in operation.

As it is necessary to take into consideration so many variable conditions, one plan or lay-out can seldom be used for two different plants. Every effort should be made to conduct

the fluid to the burners in the safest and most economical way. The underground system is preferable, as the amount of pipe required is less than in the overhead installation, and the oil can be heated more easily when the pipes are encased in a tunnel. Repairs to the distribution lines are also facilitated by the underground construction, particularly when the tunnel is covered with removable pipes. Existing pipe lines, tunnels, steam lines, and water pipes must be taken into consideration in working out the design in order to effect an economical installation.

Reducing the Friction Head

Friction head constitutes an important item in any piping installation. It is defined as the pressure in pounds per square inch normally required to overcome the pipe resistance from the pump to the burner. This frictional resistance is dependent upon a number of factors, among which may be mentioned length of the pipe, smoothness of the pipe interior, number of fittings, such as ells, checks, valves, etc., viscosity and Baumé test of the oil, oil consumption of the plant, velocity of the oil in the pipes, and inside diameter of the pipes.

The pipe lines should be laid out to conduct the oil as directly as possible from the storage tank to the furnace. The main pipe line should be kept as straight and as free from bends as possible. When the storage tank and the pipe lines are to be installed at the same time, there is a better opportunity to obtain an efficient system. Occasionally, however, the storage is limited to a given location, which often handicaps the designer. Every foot of pipe eliminated from the system represents a material saving in initial cost as well as in the future maintenance and operating cost of the system.

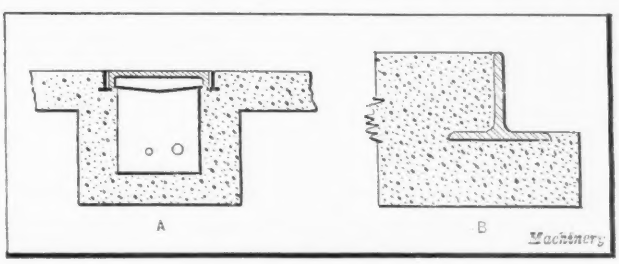


Fig. 2. (A) Cross-section of Oil-pipe Trench; (B) T-iron embedded in Trench Wall

Selecting Pipe and Fittings

The smoothness of the interior walls of commercial piping is beyond the control of the designer. This item, however, must be taken into consideration, and a pump selected that will have ample capacity to handle the required amount of oil, regardless of the condition of the inner walls of the pipe. Fittings should be used sparingly, to keep down the initial cost, as well as to reduce the frictional resistance. Gate valves are preferable to globe valves in the pipe line. Needle valves must, of course, be used on the burners. The system must be flexible, that is, valves must be so located that repairs may be made without closing down the entire system. This does not mean, however, that a valve must be placed every 10 feet or so throughout the system. The writer recalls one system that was changed over, from which sufficient valves and other fittings were removed to complete a new system that served nearly twice as many furnaces.

A valve on each branch pipe next to the main line is all that is required in the branches, aside from the throttle valve on the furnace. A by-pass may be employed to advantage between the main and return pipes, and this must be supplied with a valve in the by-pass section as well as in the main and return pipes beyond the by-pass connection. The by-pass permits any portion of the main and return pipes or loop to be closed off without closing down the entire system.

The return pipe need not be looped back in the same tunnel, as shown in Fig. 1, but could come to a dead end with no return to the tank. In some installations, the main line can be arranged to loop back or follow another line of furnaces. The frictional resistance will increase with the decrease in temperature or increase in viscosity and Baumé test of the oil. The most desirable temperature to which the oil can be heated depends upon the specific gravity of the oil. Generally the oil is heated to around 150 degrees F. at some point along the distribution line, as, for example, at the entrance to the forge shop, as indicated in Fig. 1, and delivered to the burners at this temperature. An oil having a specific gravity of between 16 and 30 Baumé is most adaptable for forge furnace heating. An oil testing below 16 Baumé invariably causes trouble because of the higher temperature to which it must be heated.

An accurate estimate of the oil consumption of the plant is desirable, but is difficult to obtain. In a steam plant we can determine the oil consumption quite readily from the boiler capacity, rate of water evaporation, or steam requirements. This is not the case, however, in the forge shop, where we are heating steel and have a great deal of waste heat which passes from the furnace and is lost so far as useful work is concerned. No doubt much of this waste heat will in time be utilized to heat boilers or for other purposes, but at the present time it is simply allowed to escape.

A considerable amount of heat is radiated by the furnace, as few, if any, attempts have been made to prevent this loss by the use of insulating material. It is probable, however, that the time will come when furnaces will be covered with some insulating material in order to eliminate this loss.

Fuel Consumption

The actual fuel consumption of a furnace depends upon the class of material to be heated, the size of the combustion chamber, the furnace construction, and the temperature to which the stock is heated. It is impossible to give a rule for determining the fuel consumption that can be applied in all cases with accurate results. For an approximate estimate, however, the following rule may be used. The number of gallons of oil per hour will equal approximately the number of cubic feet of combustion chamber volume. For example, if we measure the combustion chambers of all the furnaces installed in a given plant and find that their total volume is 84 cubic feet, we would reckon on an hourly consumption of approximately 84 gallons or 2 barrels of oil per hour. In other words, 1 gallon of oil per hour will be required for each cubic foot of combustion chamber volume.

In determining on the pipe diameter, we can assume that the oil will flow at a normal volume under the maximum consumption conditions. Otherwise, the velocity would be too high when the shop is working at a maximum rate. For all practical purposes, it can be assumed that a velocity of 100 feet per minute is sufficient. Knowing the desired velocity and the consumption, it is a simple problem in mathematics to determine the pipe diameter. If the result thus obtained is a fraction, the next larger sized pipe should be selected.

* * *

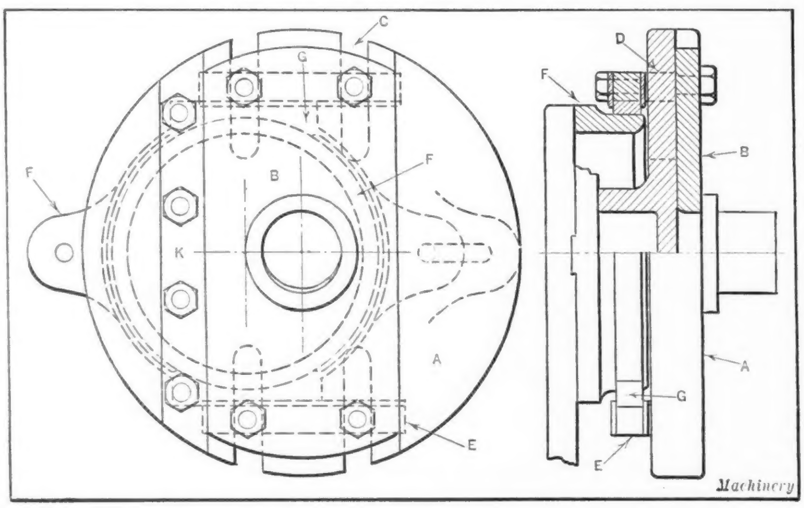
NATIONAL FOREIGN TRADE CONVENTION

The thirteenth national foreign trade convention will assemble in Charleston, S. C., April 28 to 30, with headquarters at the Francis Marion Hotel. The chairman of the National Foreign Trade Council is James A. Farrell, president of the United States Steel Corporation. Addresses and conferences will deal with such subjects as the foreign trade outlook, the commercial possibilities of South America, education for foreign trade, banking facilities for foreign trade, problems in import trade, foreign trade transportation, foreign credits, special export problems, advertising for foreign trade, building trade through foreign loans, the problem of our raw material supply, and making American competition effective. An excursion will be made on Saturday, May 1, about the harbor of Charleston, and an inspection will be made of port developments and facilities. One of the interesting features of the excursion will be a visit to the historic Forts Moultrie and Sumter. For further information, address O. K. Davis, National Foreign Trade Council, India House, 1 Hanover Square, New York City.

CHUCK FOR ELLIPTICAL TURNING

Chucks or attachments for elliptical turning are required in making oval dies, punches, molds, etc. A combined rotating and lateral motion is derived from some mechanism in order to generate the elliptical curvature. The rotary motion may be given to the work and the lateral motion to the tool, but the most common arrangement consists of a special form of chuck which is so designed that the combined motion is imparted to the work, the turning tool being held and used in the usual way. These elliptical chucks differ more or less in their construction, but the fundamental operating principle is the same. A design that has proved successful in practice is shown in the accompanying illustration.

This chuck is essentially a rotary compound slide operated by an eccentric ring termed the former ring. The ring is attached to the headstock of the lathe, or, in certain cases, is fixed to a bracket clamped to the lathe bed. The ring is adjustable in a line parallel with the surface of the bed, and at right angles to the spindle center line. In use, it is set eccentric with the center line to the amount of half the difference between the major and minor axes of the oval to be turned, irrespective of size, as this difference is maintained from the center outward to the limit of the work for each setting of the ring.



Chuck used in turning Elliptical Dies, Molds, and Similar Classes of Work

The cast-iron body *A* of the chuck is threaded to suit the nose of the headstock spindle of the lathe on which the chuck is to be used, and *B* is the slide-plate which carries the duplicate "nose" on which the chuck, faceplate, or other attachment to which the work will be fixed, is screwed. In the body are slots *C*, through which pass the studs *D*, these studs attaching the two slide-bars *E* to slide-plate *B*. Operating between the slide-bars and the eccentric ring *F* is a phosphor-bronze slipper ring *G*, the function of which is to transmit the thrust of the eccentric ring to the slide-plate. When the eccentric ring is attached direct to the lathe headstock, a suitable groove is planed across the face of the headstock to match a tongue on the lower projection of the ring. In this projection, two slots are cut to permit adjustment and at the same time allow bolts to pass through for fixing the ring to the headstock. A lug carries a set-screw by which fine settings are made. Where a bracket is used as mentioned, the method of attachment to the bracket is the same as to the headstock.

The action of the chuck is as follows: When the slide-plate is in a vertical position the center of the duplicate nose coincides with the lathe spindle center line. As the lathe spindle is rotated, the chuck body and slide revolve with it, at the same time bringing around the slipper ring, and this, on account of following the path set by the eccentric ring, thrusts forward the slide-plate through the medium of the slide-bars and studs, and brings the center of the duplicate nose forward to the amount that the eccentric ring is set over, that is, half of the difference between the major and minor axes of the oval being turned. This takes place each half revolution of the lathe spindle. The result of this combined rotary and reciprocatory motion is that the work attached to the chuck is constrained to follow an accurate elliptical path past any fixed point in the plane of motion. Thus, when a turning tool is brought against the work, an oval groove is cut therein. It is essential that the cutting edge of the turning tool be exactly on the center; otherwise, the axial lines of the oval will be distorted. The various points of the work will not then be in true relation to each other.

The heaviest wear—which, however, is very slight—takes place on the slipper ring and eccentric ring, and this is compensated for by adjusting screws. This adjustment is provided at each end in order to maintain the duplicate nose in a central position. Wear on the slide-plate is compensated for by screws acting on a strip. Where a considerable amount of oval work is done, a chuck of the elliptical type is essential.

* * *

STATISTICS OF THE AUTOMOBILE INDUSTRY

The production of passenger cars and trucks in 1925 totaled 4,325,000, of which 3,833,000 were passenger cars and 492,000 were trucks. The wholesale value of the passenger cars is estimated at $2,500,000,000, and the wholesale value of the trucks at $500,000,000. At the present time there are approximately 17,500,000 passenger cars and 2,500,000 trucks registered in the United States. It is estimated that the number of people employed in the motor vehicle and allied industries is approximately 3,200,000. There has been a great development in the motor bus field during the past year. About 70,000 buses are now in use, 15,000 having been added during the past year. The foreign trade in motor vehicles increased greatly during 1925, the total number of cars and trucks exported being about 550,000, valued at nearly $400,000,000. It is estimated that there are over 47,000 car and truck dealers in the United States, and 55,000 public garages.

* * *

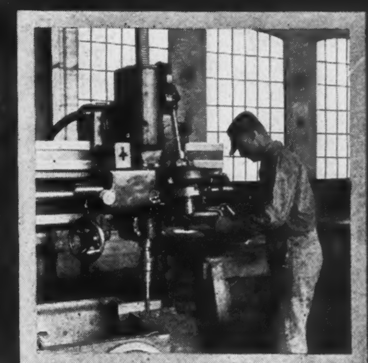
TRACTOR FOR USE IN SNOW FIELDS

An interesting automotive "vehicle" is described in the January 1 number of *Engineering*. It is known as the Armstead snow motor, and with this vehicle it is possible to pass over ground covered by heavy snow. This appliance consists essentially of a tractor engine mounted on two projectile-shaped rotating drums which serve as the skids or wheels. The rotating drums have helical flanges, the purpose of which is to propel the machine through the snow. The drums are chain-driven and revolve in opposite directions, the helical flanges being of opposite "hand" on the two cylinders; the lateral thrust is thereby neutralized, and the snow motor is propelled over the surface of the snow in a straight line. The pointed ends of the revolving cylinders press down the snow in front of the vehicle and prepare a path for the portion of the cylinders that carries the weight and propels the machine.

* * *

A census of the manufacturing activities of the United States is taken every two years. It is interesting to note the great mortality in business, together with consolidations, reorganizations and changes in names, that take place every two years. Of the 196,000 establishments that reported to the Bureau of Census in 1923, it is expected that fewer than 150,000 will appear in the records of the next census under the same names.

Letters on Practical Subjects



ADJUSTABLE DIES FOR PIERCING, FORMING, AND CUTTING OFF

In Fig. 1 is shown a set of dies for piercing, forming, and cutting off pieces like the ones shown in Fig. 3. The dies are of the progressive type, and can be adjusted to produce the various sizes of straps shown. It will be noticed that the dies are provided with four scales *A*, *B*, *C*, and *D*, Fig. 2, each of which is graduated from 3/16 to 3 1/2 inches. Three of the scales are located on the die member shown in the lower view, and one on the punch member, a plan view of which is shown in the upper part of Fig. 2. In Fig. 1 the punch member is shown in back of the die member.

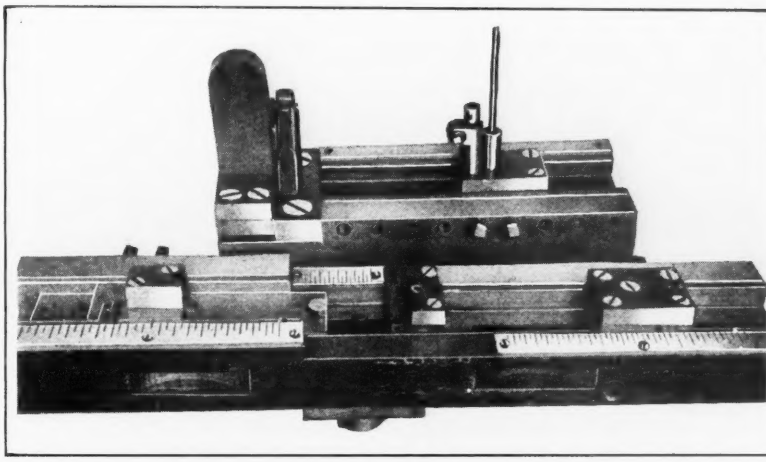


Fig. 1. Punch and Die Members of Adjustable Piercing, Forming, and Cutting-off Die

The die member consists of the adjustable piercing die *E*, the piercing and parting die *F*, the knock-out pin *G*, the bending block *H*, and the gage *I*. These tool-steel parts are all hardened and mounted on the die-shoe. The punch consists of the adjustable block *J*, with piercing punch *K* and the stamp bumper *L*, piercing punch *S*, and parting punch *M*, and a bending punch *N*. These members are also of hardened tool steel.

The adjustable members *E*, *H*, *I*, and *J* are provided with zero point indicators or lines. The method of setting the dies is as follows: First, loosen the set-screws *P*, and set members *E*, *H*, *I*, and *J*, with the aid of the zero lines, to suit the size of strap to be produced. The proper size bending punch *N* is then placed in the punch member. The knock-out pin *G*, which is actuated by a spring pressure attachment, is adjusted to the correct position in the slot *R*, so that it is in line with the center of the bending punch *N*.

When the die is ready for operation, the strip of stock, which is 1/32 inch thick and 5/16 inch wide, is fed forward until the parting punch *M* and die *F* cut the end to a semicircular shape. During the cutting-off

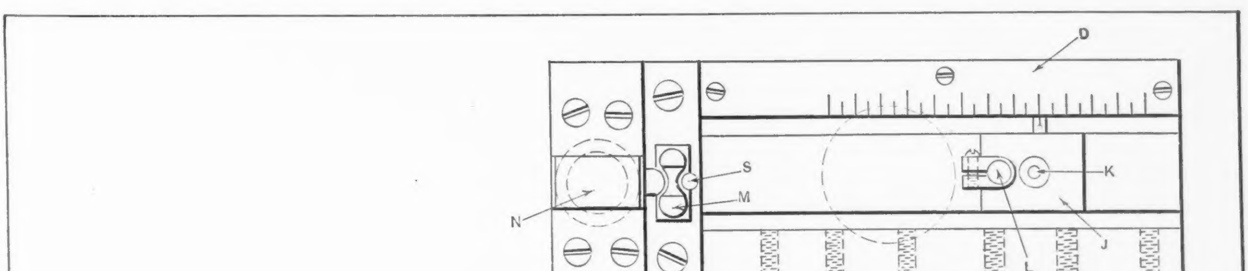


Fig. 2. Details of Punch and Die illustrated in Fig. 1

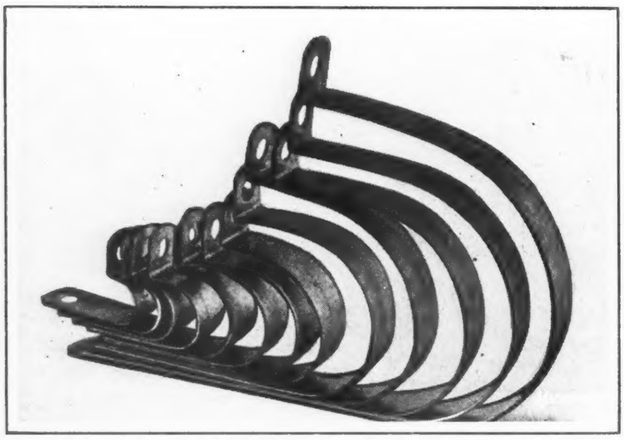


Fig. 3. Straps produced by Die shown in Fig. 1

operation, the two holes in the pieces are pierced by the punches *S* and *K*. After the first stroke of the press, the stock is advanced until it comes in contact with the gage *I*. At the second stroke, the first hole in the next piece is pierced by the long punch *K*, which serves to hold the strip from moving in either direction while the first piece is being formed to shape by the bending punch *N*.

The first piece reaches its final shape as the bending punch strikes the bottom of the die. As the downward motion continues, the bending punch compresses a coil spring in the body of the holder, which is of sufficient stiffness to permit the punch to bend the work to the required shape and then allow it to dwell during the remainder of the downward stroke while the parting and piercing punch *M* operates. On the upward stroke of the press ram, the finished piece is lifted from the die by the knock-out pin *G* and ejected by air pressure.

Ambridge, Pa. JOHN STRAMA

CAST-WELDING ALUMINUM

The process of repairing broken castings by "cast-welding" or "burning on" is not a modern one, having been known and practiced for many centuries on iron castings. The process is economical, and can often be employed with good results in repairing fractured aluminum alloy castings. It is especially useful in foundries and machine shops that are not provided with modern welding equipment and in cases where a replacement would require considerable machine work. Briefly, the process consists of pouring molten metal over the parts to be repaired or joined until they become fused together. To insure success, it is necessary that the surfaces to be joined be perfectly clean, and they should be slightly rough.

A clean yet rough surface is an important factor in obtaining a good "burn," as is also proper preheating. The molten metal or alloy used to effect the weld must be approximately of the same composition as the casting itself. The metal for welding must also be of the correct temperature and good fluidity. Sufficient metal must be run through the weld to fuse the metal. It is important also to allow a sufficient head or surplus amount of metal to insure soundness. The provision of tall "headers" is also essential, as it causes the metal to penetrate the layer of oxide on the surfaces to be joined. As aluminum becomes oxidized upon exposure to the air, the molten metals contained in it become drossy while they are being poured. For this reason, a tall "header" is an advantage, as it retains the dross, preventing it from entering the weld.

As soon as the weld is made, it should be protected in some manner that will prevent the cold air from chilling it, and the surrounding parts should also be well protected in order to bring about uniform cooling. Slow cooling after welding is just as important as slow preheating. Thousands of successful repairs to aluminum alloy castings have been made by the cast-welding method, and where the pouring of the molten metal is carefully done and proper attention is paid to the points referred to, a fractured part can be made fully as strong as the original casting. In fact, a part rarely fails at the point where the broken members are joined. It is not claimed, however, that a "burn on" is the best method of repairing fractured or defective aluminum alloy castings, but it can be said with truth that it is an economical and effective method to employ in foundries where modern welding equipment is not available and in cases where a quick repair is necessary.

Manchester, England A. EYLES

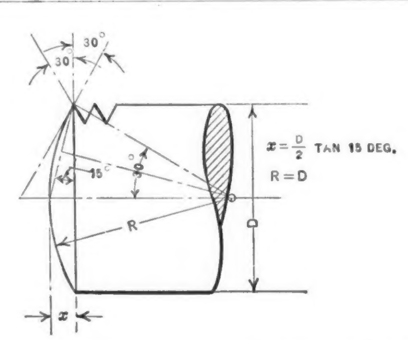
DIMENSIONS OF SPHERICAL BOLT ENDS

There have been numerous discussions regarding the standardization of bolts and nuts, but the end of the bolt that involves the starting thread, and is an important detail, has not received much attention. The bolt end should be made in such a way as to provide for quick assembly and permit the bolt to be driven from a hole in which it is a tight fit without injuring the threads. It is the writer's experience that a spherical shape on the threaded end of the bolt, as shown by the diagram in the accompanying table, is the best possible means of obtaining these desirable features.

Of course, the first thread of a bolt should be chamfered in some way to remove or prevent the forming of a fin by the cutting tool and to permit the bolt to be easily assembled with the nut without crossing the threads. The threaded end of the bolt finished flat or partly chamfered does not have a good clearance, and should it be necessary to drive it from its position, there is danger of deforming the threads near the end.

In the manufacture of bolts, it is necessary to consider the cost of production as well as the best form of end for the bolt. The writer believes that the ends of the bolts should be formed with radius tools of standard size, thus involving

DIMENSIONS OF SPHERICAL BOLT ENDS



Diameter of Bolt, Fractional Sizes	Diameter of Bolt, Inches					
	0	1	2	3	4	5
	Height x of Spherical End, Inches					
0	0.0000	0.1339	0.2679	0.4019	0.5359	0.6699
1/16	0.0084	0.1424	0.2780	0.4103	0.5443	0.6783
1/8	0.0167	0.1507	0.2847	0.4187	0.5526	0.6866
3/16	0.0250	0.1591	0.2931	0.4271	0.5610	0.6950
1/4	0.0335	0.1675	0.3014	0.4354	0.5694	0.7034
5/16	0.0419	0.1758	0.3098	0.4438	0.5778	0.7118
3/8	0.0524	0.1842	0.3182	0.4522	0.5861	0.7201
7/16	0.0586	0.1926	0.3265	0.4606	0.5945	0.7285
1/2	0.0670	0.2009	0.3349	0.4689	0.6029	0.7369
9/16	0.0700	0.2093	0.3433	0.4773	0.6112	0.7453
5/8	0.0837	0.2177	0.3517	0.4857	0.6196	0.7536
11/16	0.0930	0.2261	0.3600	0.4940	0.6280	0.7620
3/4	0.1052	0.2345	0.3684	0.5024	0.6364	0.7703
13/16	0.1088	0.2428	0.3768	0.5108	0.6448	0.7787
7/8	0.1172	0.2512	0.3852	0.5192	0.6551	0.7871
15/16	0.1256	0.2586	0.3935	0.5275	0.6615	0.7955

Machinery

no additional cost for tool equipment. As indicated in the diagram accompanying the table of dimensions, a radius equal to the diameter of the bolt will afford an ample chamfer for the thread and a crown sufficient to permit driving the bolt from a part in which it is a tight fit. A bolt with the end machined in this manner also presents a neat appearance. The radius end of the bolt should project from the surface of the nut in order to allow for the proper engagement of the threads. The commercial length of the bolt should be established as the distance from the under surface of the head to the beginning of the radius at the edge of the first thread. Thus the height x of the spherical end of the bolt will be considered only in the manufacture of bolts and not in their use.

Washington, D. C. JOHN N. SIOUSSA

MANUFACTURING LIMITS FOR DRILLED AND PUNCHED HOLES

Although the same degree of accuracy with respect to drilled, reamed, or punched holes is not required for different classes of work, it is advantageous to have a table of tolerances available, giving the limits that can be readily maintained under manufacturing conditions. The accompanying tables have been prepared with this object in view. In Table 1 are given manufacturing limits for drilled, redrilled, and reamed holes ranging in size from No. 1 drill size to 1 inch in diameter. In Table 2 are given the manufacturing tolerances on the diameters of punched holes.

Rochester, N. Y. BERNARD J. WOLFE

TABLE 1. MANUFACTURING LIMITS FOR DRILLED AND REAMED HOLES

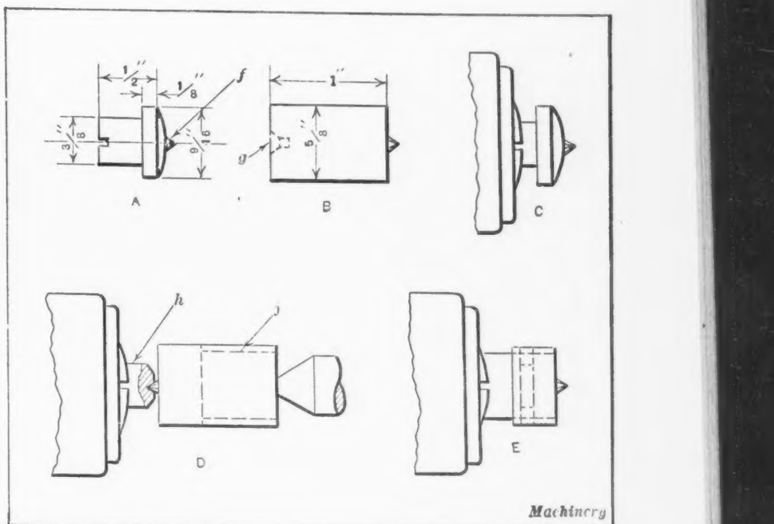
Drill Number or Size	Limits for Drilled Holes, Inches	Limits for Redrilled Holes, Inches	Limits for Reamed Holes, Inches
1 to 9	+ 0.004 — 0.001	+ 0.002 — 0.001	+ 0.001 — 0.001
10 to 19	+ 0.003 — 0.001	+ 0.002 — 0.001	+ 0.001 — 0.001
20 to 29	+ 0.0025 — 0.0010	+ 0.002 — 0.001	+ 0.001 — 0.001
30 to 49	+ 0.002 — 0.001	+ 0.0015 — 0.0010	+ 0.001 — 0.001
50 to 60	+ 0.0015 — 0.0010	+ 0.001 — 0.001	+ 0.001 — 0.001
61 to 80	+ 0.001 — 0.001	+ 0.0005 — 0.0005	+ 0.0005 — 0.0005
From No. 1 to 1/4 Inch	+ 0.005 — 0.001	+ 0.002 — 0.001	+ 0.001 — 0.001
1/4 to 1/2	+ 0.006 — 0.000	+ 0.003 — 0.001	+ 0.0015 — 0.0010
1/2 to 3/4	+ 0.008 — 0.000	+ 0.004 — 0.001	+ 0.0015 — 0.0010
3/4 to 1	+ 0.010 — 0.000	+ 0.006 — 0.001	+ 0.002 — 0.001

Machinery

TABLE 2. MANUFACTURING LIMITS FOR PUNCHED HOLES

Size of Hole, Number of Stubbs Steel Wire Gage	Limits for Punched Holes	Size of Hole, Number of Stubbs Steel Wire Gage	Limits for Punched Holes
9 and over	+ 0.000 — 0.004	30 to 49	+ 0.000 — 0.002
10 to 19	+ 0.000 — 0.003	50 to 60	+ 0.0000 — 0.0015
20 to 29	+ 0.0000 — 0.0025	61 to 80	+ 0.000 — 0.001

Machinery



Diagrams illustrating Procedure in making Diamond Holder

METHOD OF MOUNTING TRUING DIAMONDS

Setting truing diamonds for ordinary use, such as truing emery wheels by hand, is an operation that ordinarily does not attract attention. An unusual mounting for a truing diamond, however is shown at *A* in the illustration. The diamond *f*, in this case, was required to have the point precisely in line with the axis of the holder. The steps taken to accomplish this were as follows:

First a diamond was selected having a symmetrical body and a point of the shape best adapted for the purpose. This diamond was set in the usual way in a piece of 5/8-inch round brass rod. The mounting was then centered on the opposite end *g*, as shown in view *B*. A short piece of 3/8-inch cold-rolled steel *h* (view *D*) held in the spring collet was centered, as shown. The piece *h* is left soft, and serves to center the diamond while turning the body down, as indicated by the dotted lines *j*.

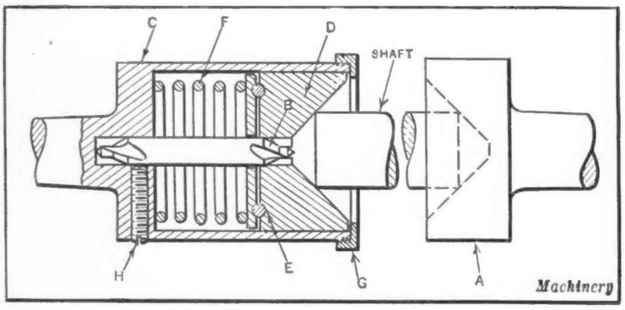
The holder is then placed in a 9/16-inch spring chuck as shown at *E*, and the head end turned to match the 9/16-inch diameter already turned on the opposite end of the piece. A 1/8-inch parting tool is next run into the 3/8-inch finished shank end of the holder at a point 3/16 inch from the end in which the diamond is held.* This leaves enough material for rounding the head end of the holder, as shown in view *A*. The holder is again reversed in the spring chuck and the 3/8-inch diameter finished and cut off to the proper length. Then the holder is again gripped in the chuck, and rounded over with a hand tool, as shown at *C*, and polished with emery cloth.

Seneca Falls, N. Y. H. L. WHEELER

SHAFT-CENTERING TOOL

A tool designed for the rapid and accurate centering of shafts is shown in the accompanying illustration. This kind of tool will be found particularly useful in machine shops that are not equipped with a centering machine. The hollow center *A* serves to locate one end of the work while the other end is being centered by the centering drill *B*. The centering drill is clamped in the holder *C*, which is held in the lathe spindle. The hollow locating center shown at *D* serves to align the end of the shaft to be centered with the center drill *B*.

In centering a shaft, the workman simply places one end in the locating center *D* and the other end in the hollow center *A*, and employs the tailstock spindle handwheel to feed the work to the center drill. The workman grips the shaft tightly to prevent it from rotating during the centering operation. The ball thrust bearing at *E* permits the locating center *D* to remain stationary while the holder *C*, center



Shaft-centering Tool for Lathe

drill *B*, and spring *F* revolve. The cap *G* serves to retain the loose members within the holder *C*. A set-screw *H* prevents the center drill from turning in the holder.

In constructing a centering tool of this kind, care must be taken to provide sufficient space back of the thrust bearing *E* to allow spring *F* to be compressed sufficiently to permit the centering of shafts of relatively larger size than that shown in the illustration. The locating center *D* should, of course, be a good running fit in the holder *C*.

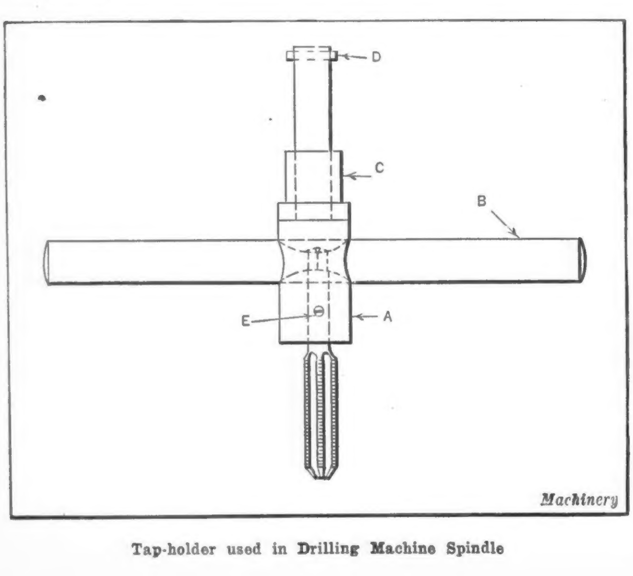
Philadelphia, Pa. CHARLES KUGLER

TAP-HOLDER FOR DRILL SPINDLE

Many tapped holes can be produced properly only by tapping them while the work is set up for drilling. The special tap-holder shown in the accompanying illustration is useful for tapping holes in work of this kind. It can be gripped in the chuck as readily as the drill, and can be used without loosening or removing the drilling machine drive belt, as must be done when the tap is gripped in the drill spindle chuck. The holder is made up of three parts. The body *A* is drilled at the lower end to receive the shank of the tap and also has a cross-hole drilled through the side to receive the wrench *B*. The wrench is flattened at the center, and has a square hole cut through the flattened part which fits the square end of the tap.

The bushing *C* is a running fit on the turned-down portion or shank of body *A*. The pin *D* in the shank end of body *A* serves to retain the bushing *C*, and the screw *E* prevents the tap from falling out. After the hole in the work has been drilled and the drill removed from the chuck, the tap-holder is brought into use, the bushing *C* being gripped in the drill spindle chuck. The drill spindle is then fed down until the tap comes in contact with the work and the bushing *C* is in the position shown, after which the hole is tapped simply by turning the wrench *B* by hand. The bushing *C* remains stationary in the drill chuck, and serves to keep the tap properly aligned with the drilled hole during the tapping operation.

Montreal, Canada NORMAN MOORE



Tap-holder used in Drilling Machine Spindle

AN ALL-POSITION OIL-RING BEARING

Bearings lubricated by oil-rings are ordinarily thought of in connection with shafts intended for operation in approximately a horizontal position. That such limitations do not exist is evidenced by an application of this method of lubrication to the bearing shown in Fig. 1. The bearing was required to function perfectly in any position from 15 degrees below the horizontal to 85 degrees above. As it is used in a locality where castor bean and ground nut oil is always available, oil lubrication is preferred to grease. Also an oil-ring system is preferred to the wick or pad method of conveying oil to the bearing surface.

A cross-section of the bearing, as developed, is shown in Fig. 1. The part *A* is a steel thimble, turned all over and ground on the bearing surfaces. This is mounted on the shaft with a light press fit in order to permit it to be removed with a minimum amount of danger of kinking the shaft. Tapped holes for "come-alongs" are put in the upper surface of the thimble to facilitate its removal. It is held against longitudinal displacement by a set-screw spotted into the shaft. Taper fits were not permissible, because of

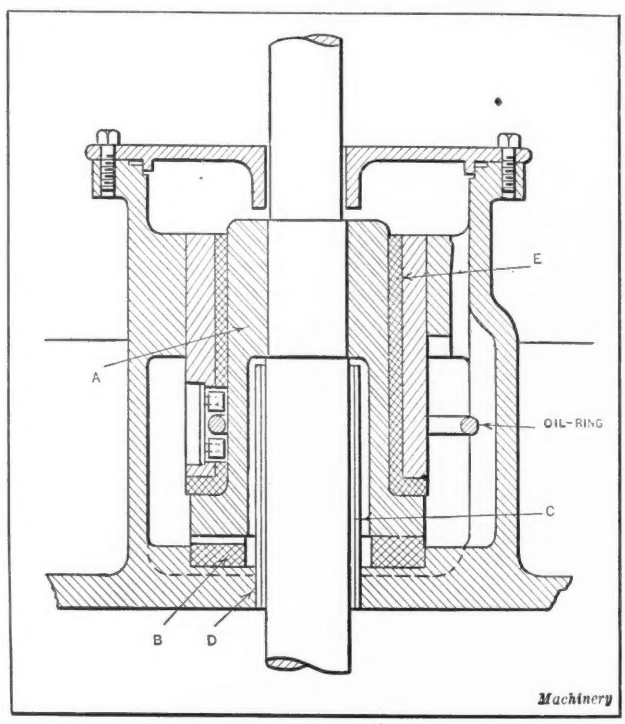


Fig. 1. Bearing designed for Use in approximately a Vertical Position

the difficulty of making a good repair job in the field where suitable machine tool equipment is not available. The thimble bears against two washers, one of a flat disk form shown at *B*, Figs. 1 and 2, which serves as a thrust, and the other of a bushing form *E*, Fig. 1, which encircles the cylindrical portion of the thimble and acts as the conventional journal box. The bushing is lubricated by a split oil-ring of circular cross-section.

The ring slot is end-milled to the shape shown at *H*, Fig. 3. The shape is such that the ring revolves freely with the shaft in any position from 15 degrees below the horizontal to 15 degrees above; in the latter position, the thimble dips into the oil sufficiently to provide adequate lubrication. The rollers shown at *F* were employed to lessen ring friction. Although not shown in the illustration, the countersink in the end of the roller is made slightly more obtuse than the screw head, to lessen the friction of the rolls themselves.

In the case of a horizontal bearing, the weight of the shaft causes the shaft to assume a slightly eccentric position in the bearing. This condition permits a thin tapering wedge of oil to creep in between the friction surfaces. In a vertical thrust bearing this desirable condition does not exist,

and as a consequence, such thrust bearings are generally troublesome and demand special treatment.

In the present case, three radial grooves are cut in the thrust member *B*, Fig. 1, which terminate at the inner periphery of the disk in feed grooves, as shown in Fig. 2. Next, the bearing surface is scraped, so that midway between the grooves there is a land 0.005 inch higher than the surface at the oil-groove. The inclined plane corresponds with the clearance in a cylindrical bearing and permits the oil film to form and be maintained. The incline leading to the land and the land form the effective bearing surface. The incline leading from the land serves no useful purpose and often is a detriment, as it causes foaming. For this reason bearings for shafts which revolve in only one direction should have steps with only one incline. For reversible shafts, however, it is necessary to provide an incline at both sides of the land, as in the bearing shown. For theoretically correct action, the step should be made segmental and of the Kingsbury type, but the arrangement shown is practical for

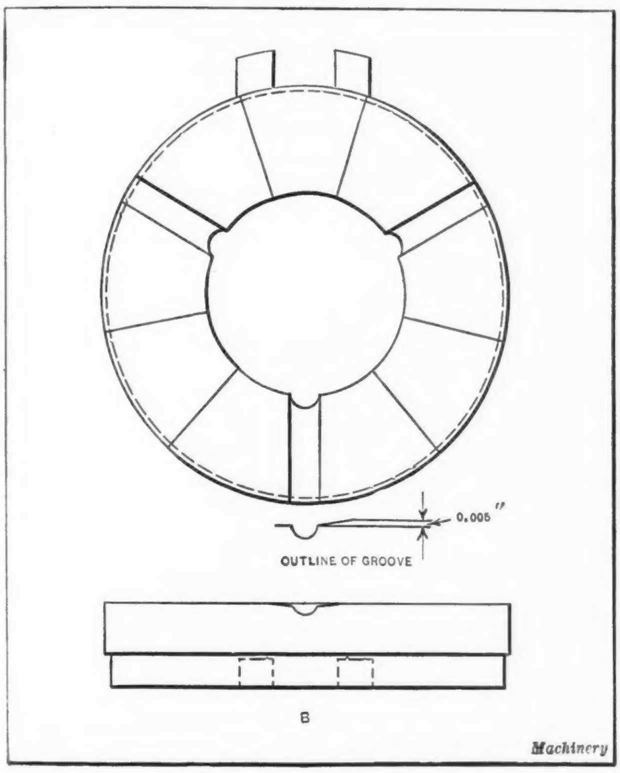


Fig. 2. Thrust Washer used in Bearing shown in Fig. 1

a moderate sized bearing, and it is not subject to disarrangement.

The bearing housing must be of special construction in order to keep the oil from spilling out and at the same time keep the level of the oil right for all angular positions. This and the necessity of providing suitable oil capacity make the housing seem large in comparison with the shaft. The lack of proportion, however, is more evident in the illustration than in the actual bearing. To prevent oil leakage, a piece of boiler tube *C*, Fig. 1, was expanded into the housing at *D*. This projects as far as space will permit into the thimble.

On the upper side of the housing is a cover that is tightly bolted in place. Between the cover and housing is a copper and asbestos gasket. In facing up the cover and housing for this gasket, it was noticed that when an ordinary finishing tool was used, with cross-feed, the joint could not be made oil-tight without the gasket, but when a broad-nosed tool, ground flat and wide enough to face the surface without touching the cross-feed was employed, the joint was oil-tight. It was deemed advisable, however, to use the gasket as a safeguard. Projecting down from the cover is an annular lip which prevents oil from splashing out in case the shaft is suddenly tilted. The name "all-position," as applied

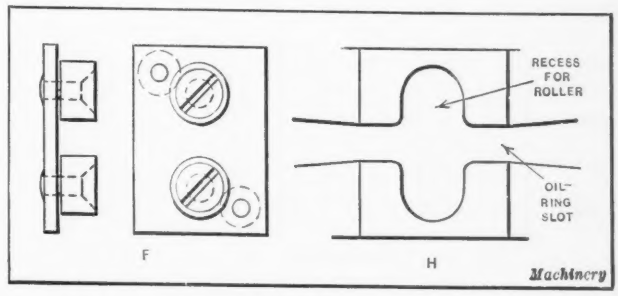


Fig. 3. Oil-ring Supporting Rollers and Detail of Ring Groove

to the bearing here described, may be rather a misnomer, but it is evident that by proper proportioning of the various details, it could be made to operate in any position.

Willimantic, Conn. HERBERT A. FREEMAN

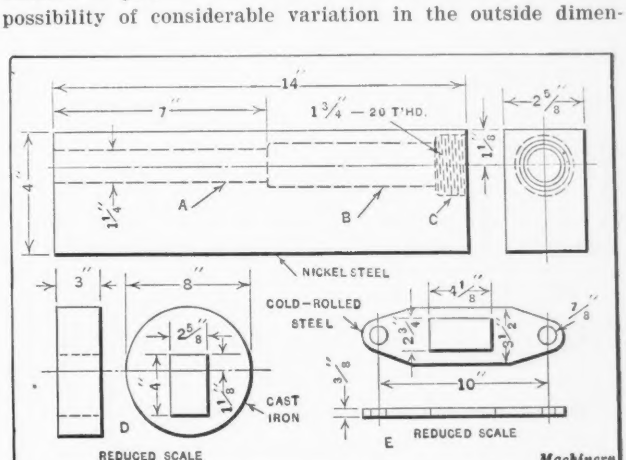
DRILLING A DEEP HOLE

The drilling and threading of the nickel steel piece shown in the upper view of the accompanying illustration presented a rather interesting problem, which was satisfactorily handled in the manner described in the following. The hole *A*, the counterbore *B*, and the threaded hole *C* were all required to be concentric and of accurate size. The piece was first machined on the outside and accurately centered at each end. These operations were performed on a milling machine. The next step was to make a cast-iron bushing such as shown at *D*. This bushing was squared up in a lathe from a center hole, and the rectangular slot machined on a vertical shaper to give a light drive fit on the work.

The outside diameter of the bushing was turned after being driven on the work, which was mounted on the lathe centers. The next step was to mount the work on the lathe with one end on the faceplate center and the opposite end held in the bushing *D* which was supported in the center-rest. The work was driven by an ordinary clamp dog, and was held back on the center by the plate *E*. This plate was made a loose fit on the work, and was clamped against the lathe dog by two bolts which extended from the faceplate. With this arrangement the work was held firmly against the faceplate center.

The 1 1/4-inch hole *A* was drilled and bored with an ordinary lathe boring tool held in the toolpost. As large a boring tool as it was possible to use was employed in order to obtain sufficient rigidity. After chamfering the hole to fit the lathe center, the work was reset by shifting the bushing *D* to the opposite end of the work and swinging it in the lathe as before, except that the positions of the ends were reversed.

Then the 1 1/2-inch hole *B* was drilled and bored, the threaded hole *C* bored, and the thread cut. Care was taken to have the bushing a good fit on the work. When a large number of pieces were to be machined and there was the possibility of considerable variation in the outside dimen-



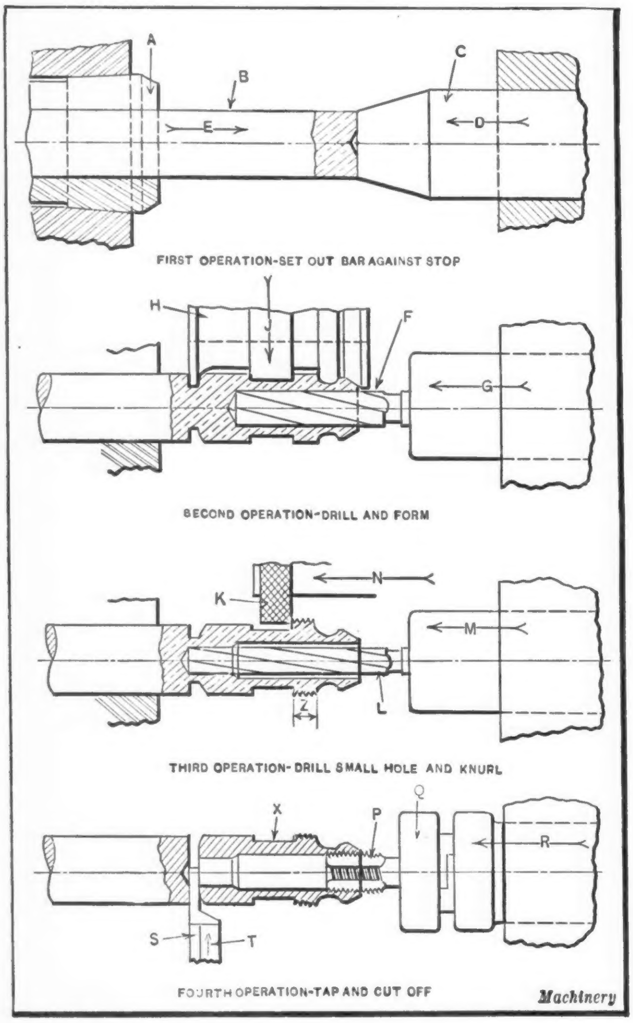
Work in which Hole was drilled, and Fixtures used to hold Work

sions, the bushing D was provided with set-screws for adjusting or truing it up at each setting. This method is often employed in using center-rest bushings for turning rough round bars, in which case the bushing is generally referred to as a "cathead."

Pawtucket, R. I. S. W. BROWN

DRAWINGS FOR SCREW MACHINE OPERATIONS

Various types of drawings are used to show the sequence of operations required in manufacturing a part on a screw machine. One of the simplest and perhaps most convenient forms is shown as an example in the accompanying illustration. In this case, as the drawing clearly shows, four sets of tools are employed which are located in different positions on the turret of the screw machine and used in combination with a set of front and rear cross-slide tools.



Screw Machine Operation Sheet

The work, a cross-section of which is shown at X in the lower view, is machined from bar stock.

The drawing, as made, shows how the chuck A, held in the spindle of the screw machine, grips the bar stock B, the stop C in the turret being advanced in the direction D to a predetermined point, following which stock B is fed in the direction of arrow E until it comes against the stop. After the stock is correctly located and clamped in place, the screw machine turret is indexed to the next stop, where the drill F is advanced in the direction indicated by arrow G, and at the same time the form cutter H is fed in the direction of arrow J. The part is thus simultaneously turned to shape and drilled, the turning tool H being mounted on the rear cross-slide.

Next, the work is again indexed, bringing the knurling tool K into position for knurling the work at Z. A pair of spiral knurls K, secured in a standard type of holder mounted on the turret, are used for this operation. While the knurling operation is being performed, a drill L of smaller diameter than the one shown at F is fed into the work. Both the drill and the knurls are fed simultaneously in the direction indicated by the arrows N and M, the cross-slide of the machine remaining idle during the operation. The final operation consists of tapping the end of the part with a tap P held in the holder Q which is advanced in the direction indicated by arrow R. While the thread is being tapped, the cutting-off tool S is fed in the direction indicated by arrow T.

Holyoke, Mass. FRANK H. MAYOH

STRENGTH OF TUBES USED AS ROLLERS

In building an experimental printing machine, a steel tube, 6 inches in diameter and 1 foot long, having a wall 3/4 inch thick, was used as a cylinder in place of the customary cast-iron cylinder. In attempting to determine the margin of strength and the deflection of the steel tube under printing pressures, the designer experienced difficulty in finding formulas that applied to hollow rollers of this kind.

Application to the different tube manufacturers failed to bring forth any definite information. One concern had made some tests upon wrought-iron pipe of various weights for the purpose of determining the elastic limit of pipe under a dead load. As was to be expected, these tests showed that the load any given size of pipe would carry was proportionate to the length, after the length had been increased from mere rings of pipe to what would regularly be considered a roller. All the tests were carried out on 3-inch standard weight pipe, which has a wall thickness of 0.216 inch. The elastic limit for a piece 1 inch long was found to be 875 pounds; 3 inches long, 3000 pounds; 12 inches long, 10,000 pounds; and 24 inches long, 20,000 pounds.

These tests are not evidence of strength under rolling loads, but are merely static tests. They are interesting and helpful, nevertheless, to those who must use hollow rollers for various purposes. The loads given are not in pounds per square inch but total loads, the rollers having, theoretically at least, only line contact at the top and bottom. This data was used as a check on the method finally used to calculate the strength and deflection when 6-inch instead of 3-inch cylinders were used.

The cylinder wall was considered as though it were a simple beam supported—not fixed—at both ends and having a concentrated load in the middle. That this will give a greater resistance than a straight beam of the same section is acknowledged, but the assumption was on the safe side and proved to be an acceptable medium for calculation. The calculations made in this way for a 3-inch pipe were compared with the amount of deflection actually noted when loading a piece of pipe of the same size with a 3000-pound weight. Measuring the deformation on the diameter indicated that the theory was workable.

Middletown, N. Y. DONALD A. HAMPSON

* * *

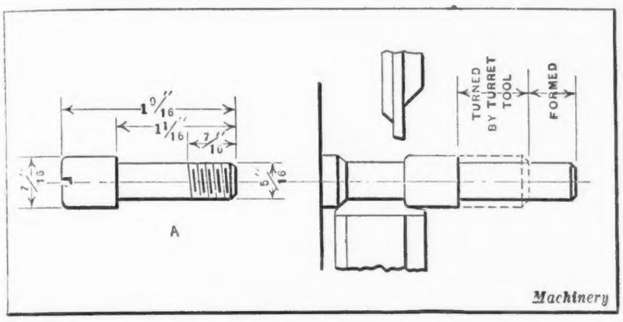
HANDBOOK OF AUTOMOBILES

The National Automobile Chamber of Commerce, 366 Madison Ave., New York City, has issued its annual Handbook of Automobiles, listing the cars built by the members of the Chamber, which include practically all the important automobile, truck, and motor bus builders, with the exception of Ford. Illustrated specifications are given of 178 motor vehicles, with 770 models listed. The specifications are grouped in four sections and include 100 passenger cars, 5 taxicabs, 15 motor buses, and 58 commercial cars and trucks. All of these are gasoline-driven, with the exception of three electric commercial vehicles. The list of makers includes 50 builders of passenger cars, 5 builders of taxicabs, 11 builders of motor buses, and 37 builders of commercial cars and trucks. Copies of this handbook may be obtained from the National Automobile Chamber of Commerce. The price is 50 cents.

Shop and Drafting-room Kinks

SCREW MACHINE SHORT-CUT

The piece *A* shown in the illustration is produced on a No. 0 Brown & Sharpe automatic screw machine by a method that is somewhat different from, and much faster than, stan-



Part made on Screw Machine and Diagram illustrating Machining Method

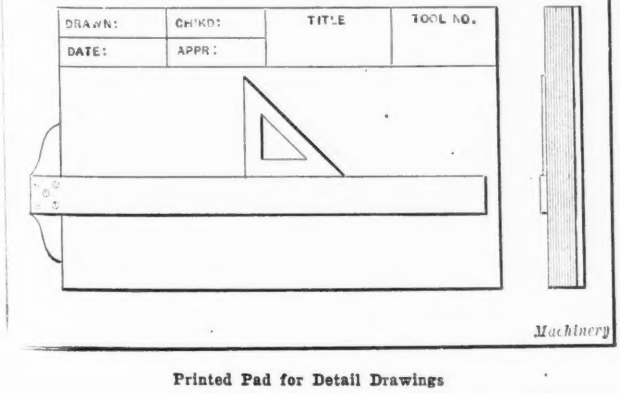
dard practice. Instead of turning the entire length of 1 1/16 inches with a hollow mill and box-tool mounted on the turret, a form tool is used to reduce the threaded end to size, leaving a length of only 5/8 inch to be finished by the turret tools. Thus the cross-slide and turret tools work simultaneously on the same diameter, which results in reducing the turning time 40 per cent. The formed diameter is a few thousandths inch under the diameter turned by the box-tool so that the latter tool passes over the formed part freely. The shoulder between the two diameters cannot be detected after the work is threaded.

Eastwood, N. Y. ELMER C. COOLEY

DETAIL DRAWING WITH CARBON COPIES

The system for making detail drawings for tools and special parts here described was used in a drafting-room where the writer was once employed. The company was engaged in the manufacture of small quantities of very high-grade instruments. The jigs and fixtures employed were of the simplest, and principally of the built-up type. The drafting system, which was equally as simple, consisted of first making a lay-out and then turning the lay-out over to a detailer who made the working or detail drawings on sheets like the one shown in the illustration. These were made up in the form of pads containing 100 sheets bound together with a very heavy cardboard backing.

Each sheet was printed about as shown in the illustration, and instead of fastening the detail sheets to a board, the detailer worked directly on the pad, using a small T-square



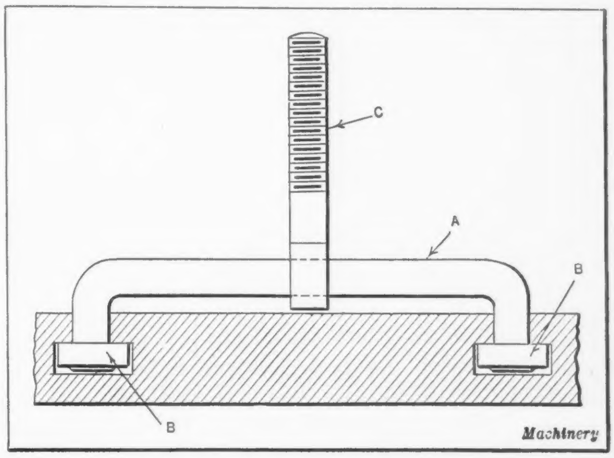
Printed Pad for Detail Drawings

guided by one edge of the pad. Between each two sheets was placed a carbon paper such as is used by typists. The detail drawing on the top sheet was thus reproduced on the sheet directly beneath. The carbon copy was sent to the shop as a working drawing and the original was kept as a record. This system eliminated practically all blueprinting, and enabled a fixture to be brought out with a minimum loss of time. All details except those of very large parts were drawn up in the manner described, and while the drawings were not very elaborate, they served their purpose in a satisfactory manner.

New York City B. J. STERN

ADJUSTABLE CLAMPING BOLT FOR MACHINE TABLE

It frequently happens that a piece of work requires clamping at some point where it is impossible to use a regular clamping bolt in the table T-slot. Duplicate bolt straps can be used sometimes in such cases, but considerable setting up work is necessary. A method of overcoming this trouble is to use an adjustable bolt, such as shown in the accompanying



Adjustable Clamping Bolt for Machine Table

illustration. This bolt is made from a length of round stock *A*, bent over at both ends to fit adjacent slots in the table. Collars *B* are driven on the ends, which are then riveted over. The eye-bolt *C* is a sliding fit on bar *A*. With a bolt of this kind, the work can be clamped at almost any point, as the bolt *C* can be slid along bar *A*, and the bar can, in turn, be slid along the machine table, thus providing for longitudinal as well as transverse adjustment of the bolt.

Montreal, Canada NORMAN MOORE

DRAWING ARCS TANGENT TO INTERSECTING LINES

A drafting-room kink which the writer has found useful when drawing arcs tangent to two intersecting lines is described in the following. On a small piece of tracing cloth, draw circles, each marked with its radius. These circles should have radii corresponding to the sizes of the arcs ordinarily used. To draw an arc of a given radius tangent to two intersecting lines, place the tracing over the drawing so that the circle having the required radius is tangent to the lines, and transfer the center on the tracing to the drawing with a prick mark. The compass is then set to the required radius, and the prick mark located by means of the tracing is used as the center in drawing the required arc.

Brooklyn, N. Y. DANIEL D. MOLONY

Questions and Answers

SETTING CUTTER FOR MILLING SPIRAL FLUTES

E. W. D.—In milling a tapered spiral reamer with a 48- by 12-degree cutter, should the cutter be centered when the bed is in the zero position or after the bed has been swung around to the proper angle?

A.—In setting a cutter for milling spiral flutes, the following procedure is recommended. First, locate the cutter directly above the center of the work, so that the cutter axis is in the same plane as the end of the work; then, adjust the table to the spiral angle; and finally, adjust the work laterally and vertically so that the trial cut at the end of the blank is properly located. For instance, if the 12-degree side of the cutter is to be radial, so that the front faces of the reamer teeth are radial, this final adjustment can readily be made by scribing lines on the end of the blank representing one of the tooth spaces and setting the cutter with reference to them.

IMPROVEMENTS IN SHOP PRACTICE CHARGED TO OVERHEAD

B. T.—An expert on machine shop practice and machine tool design has been engaged in improving the methods and tool equipment used in a certain machine shop, the result being a considerable increase in the output from several machines. The salary received by this expert has been charged to overhead, but in certain instances the gains in output were offset by this increase in overhead; consequently certain of these improvements did not show a profit, and it was decided to decrease the overhead by discontinuing this branch of the work. As the expert has lost his job, he feels that this overhead charge is altogether responsible and that this is not a rational method of cost accounting. His theory is that a man who increases production is a *producer*, even though he does not actually run a machine. Should this man's salary have been charged to overhead?

ANSWERED BY J. A. THOMAS, LOS ANGELES, CAL.

The proprietor in charging the expert's salary to overhead has, it seems to me, handled it in the correct manner. The expert, if a producer, was such for a short time only. His work resulted in the increased efficiency of several machines, but unless he was actually operating one of those machines, adding his time to the work would give a false cost record or a cost that would be of no use for future guidance either for time consumed or wages paid.

If his time were to be charged directly to the work, then it might be distributed over the work done on the various machines that his instructions effected savings on. This method, however, would give a false cost account, because when his services were dispensed with, that item of cost would no longer continue; hence all subsequent work done under his plan would be cheaper in time and presumably in wages. This is assuming that his time and wages were directly charged to the work produced under his guidance. If his time were charged to overhead, the cost of the work would not be affected radically, and the cost of employing him would appear in the "burden." The future increased efficiency of the machine operator would be shown in the time reduction or in the lower wages paid on account of less time required per unit of work.

If the shop in question is a large one, the overhead will not be affected very much by absorbing the expert's wages, but if it is a small shop, the overhead may be considerably increased throughout the time he was employed. If the burden is determined over a long period of time, the amount that will be added to the unit of burden will not be very great, and as time goes on the burden will settle back to its normal rate or nearly so. The chief result desired in cost accounting is to get a time record and cost that will be something like a normal cost in time consumed, and one that will be useful for future work and cost accounting, and the writer would consider the charging of this expert's time to the work done an abnormal charge. If he were to be employed steadily on the same work and his time could be distributed among the different machines fairly equitably, a charge directly against the work would be justifiable. Even in this event it would be more easily distributed by adding his time into the overhead, the same as the foreman's time.

A cost system is more valuable for its usefulness in making comparisons, showing where time can be cut, estimating, and as assistance in shop management, than as a medium for merely getting a cost result. Comparisons, time reductions, etc., can only be based upon time consumed in doing work. The time distribution must be as accurate as it can be made. Overhead charges can never be divided or apportioned absolutely correctly.

JOBBING SHOP RATES

H. M.—I would like to obtain information in regard to jobbing shop rates per hour in different parts of the country.

A.—The following rates, effective in a first-class jobbing shop in New York City, will indicate the average charges in this locality. These rates include, of course, labor and overhead.

For work performed on planers, from \$2 to \$2.40 per hour, according to the size of the planer. The higher rate applies to a planer 60 inches wide. For lathes, from \$1.75 to \$2.25 per hour, according to the size of the lathe, the lower figure applying to lathes from 16 to 20 inches, and the higher figure to lathes from 30 to 48 inches. For turret lathe work, a rate of \$2 per hour is generally charged. For shaper work, a uniform rate of \$1.75 an hour is the average charge.

It would be of interest to obtain figures for jobbing work performed on various classes of machines in different parts of the country. MACHINERY's readers are invited to send this information to the editor for publication in this column.

DIVISION OF MONEY IN GANG WORK

T. C. D.—A gang of five men receiving different rates of pay has worked together on one job for which \$405 is to be distributed among the men in proportion to the hourly rates and the different lengths of time each man has worked. How are these amounts to be determined? The hourly rates are as follows: A receives 80 cents; B, 72 cents; C, 50 cents; D, 47 1/2 cents; and E, 35 cents. The hours each man worked are as follows: A, 120 hours; B, 115 hours; C, 122 hours; D, 118 hours; E, 113 hours.

A.—The first step is to determine how much each man would have received for working the given number of hours at the given rate per hour. This amount is equal, of course, to the number of hours multiplied by the hourly rate. In this particular example, the man (designated by A) whose rate is 80 cents an hour would receive a total of \$96 for 120 hours' work; B, \$82.80; C, \$61; D, \$56.05; and E, \$39.55. Next add all these amounts, thus obtaining a total of \$335.40. Then divide the total amount of money actually received by the gang of five men, or \$405, by \$335.40, to get the percentage of increase. In this example each man receives nearly 21 per cent more, because \$405 is nearly 21 per cent more than \$335.40. Thus, $405 \div 335.40 = 1.2075$. Hence

A receives	\$96.00	× 1.2075	=	\$115.92
B receives	82.80	× 1.2075	=	99.98
C receives	61.00	× 1.2075	=	73.66
D receives	56.05	× 1.2075	=	67.68
E receives	39.55	× 1.2075	=	47.76
			Total =	\$405.00

STELLITE SURFACING OR "STELLITING"

In a paper read before the Boston section of the American Welding Society on February 19, A. V. Harris, of the Haynes-Stellite Co., described a new process whereby stellite is applied to the surface of metal parts that are called upon to withstand heat, abrasion, corrosion, or a combination of these. This process of applying or coating a surface with stellite is known as "stelliting." It can be done by means of the oxy-acetylene blow-pipe or by the electric carbon arc.

Among the qualities of stellite that are generally known are resistance to abrasion, ability to retain its hardness up to 1800 degrees F., and ability to resist almost every kind of chemical corrosion. In the following, applications of stelliting for different purposes will be described under the three classifications mentioned—first, where resistance to abrasion is the most important object; second, where resistance to heat is necessary; and third, where resistance to corrosion is the most important characteristic. Obviously, there is no clean-cut distinction between these applications, and at times all three properties may be equally important.

"Stelliting" with a View to Increasing the Resistance to Abrasion

Every mechanical man has had difficulty at some time with metal parts wearing out too quickly. In forge shops and press rooms, dies are subjected to great wear. The stelliting process has been applied in Canton, Ohio, to bending, forming, and trimming dies used in the manufacture of railroad supplies. A forming die made of high-grade alloy steel and costing about $50 ordinarily produced from 6000 to 10,000 parts before it had to be discarded. One of these worn out dies was stellited and ground to size at a cost of $10; it was then used for 100,000 pieces before it lost its size. The saving on tools on this particular job was—conservatively stated—over $400 in a period of three months. This does not cover the saving in productive time due to not having to change dies so often.

Another die in the same shop is used for trimming the flash from drop-forgings. A 30-pound die of chrome-nickel steel which trimmed the flash from counterbalance weights for automobile crankshafts had a life of 2000 pieces before reconditioning was necessary. This die was stellited and reground after it had lost its size. It then trimmed 7000 pieces before reconditioning was necessary. Many examples of this kind could be given.

An important point in connection with these records is that after the stellited part has lost its size, it can be restellited at a cost less than the first application, because the surface is in a good condition to receive a new stellite coating. Obviously, there are an almost unlimited number of machine parts such as cams, trips, dogs, and chucks that can be stellited with profit. Generally speaking, experience has shown that any part called upon to stand wear or abrasion will have its life increased from three to ten times by "stelliting."

In the cement industry and in any other field where crushing or pulverizing equipment is used, the life of the wearing parts can be increased by "stelliting." The life of screw conveyors, for example, used to transport ground material through pipes or troughs has been increased more than six times by "stelliting" the first few flights where the greatest wear occurs. Mr. Harris mentioned that the Fuller Lehigh Co., Fullerton, Pa., has recently adopted as standard practice, the "stelliting" of the surfaces of all wearing parts in its line of machinery.

"Stelliting" to Produce a Heat-resisting Material

In very few places is resistance to heat the sole object of "stelliting"—usually the part is called upon to withstand abrasion at a high temperature. Stellite retains its hardness at temperatures several hundred degrees higher than the best grades of steel. It is this property that has made its use so general in the metal-cutting field. Furthermore, it is not annealed by continued exposure to heat, but, upon cooling, possesses its original hardness. In many operations as, for example, the trimming of hot forgings, it is the heat of the forging that is largely the cause of the rapid failure of steel dies. For such work, stellited surfaces give remarkable results on account of their resistance to high red heats and their ability to retain their hardness when subjected to such heat.

Again going to the cement industry for an illustration of a most severe duty, we may take, as an example, the manufacture of Portland cement, where white-hot clinker drops from the kiln and is taken away by a drag chain. This chain is generally made of manganese steel links 1 inch thick, 12 inches wide, and 15 inches long. The hot clinker is caught in the center opening of the chain link and carried away to storage or to a quenching tank.

On account of the size and weight of the chain, it must be supported on bars or plates. The supporting bar or plate is subjected not only to the intense heat of the white-hot clinker, but also to the abrasion of the chain. The supporting bar, generally made of manganese steel or chilled white iron, lasts only a very short time before it must be replaced. Water-cooled castings are frequently used for these bars, but the advantage is very slight. Usually a new design is necessary in order to make a successful application of "stelliting" in this case. With stellite built up on the wearing surface, it was found that at the end of 500 hours of continuous service, the stellited surface showed only 1/16 inch wear, in comparison with 2 inches wear on chilled white iron. The cement plants are rapidly adopting stellite for this use.

"Stelliting" to Resist Chemical Corrosion

In the manufacture of dry batteries, a number of dies and machine parts come in contact with active chemicals that tend to corrode and destroy the texture of the metal. Here, again, we have a combination of chemical corrosion and abrasion. In one instance, stellited dies for batteries lasted six times longer than special alloy steel dies. Valves and valve seats for use in mixing equipment, plungers and cylinder liners for chemical equipment, and many other chemical machinery parts have been successfully stellited.

Stellite has many other interesting applications based on certain other properties which, however, are of relatively less importance in the general industrial field. For example, it is non-magnetic, and has been the means of making a certain type of electric hammer practicable. When the plunger is made of steel, it becomes magnetized after a short period. By "stelliting" both ends of the plunger, the trouble is eliminated. Stellite takes a beautiful polish—equal to silver or platinum—and retains this polish indefinitely, because it is not affected by exposure to moisture or the atmosphere. This has led to its use in reflectors and mirrors of various kinds, where a lasting, unbreakable reflecting surface is required.

* * *

DEPARTMENT OF COMMERCE'S SERVICE TO TRAVELERS

In a bulletin issued by the National Machine Tool Builders' Association, J. E. Andress, chairman of the committee on cooperation with the Department of Commerce, calls attention to the specific service that can be rendered by the Machinery Division of the Bureau of Foreign and Domestic Commerce to members who intend to visit foreign countries. There are various laws affecting travelers and traveling salesmen which should be understood before entering the different countries; for example, there are customs provisions affecting baggage or samples, and legal problems sometimes arise. It is well to have certain knowledge regarding commercial and social customs of the country to be visited, and information that will facilitate the handling of money matters and business transactions. In addition, it is important to have the fullest information regarding the machinery dealers in each territory. The Department of Commerce can supply information covering all these points, and those who are contemplating traveling abroad would do well to take advantage of this service before they start.

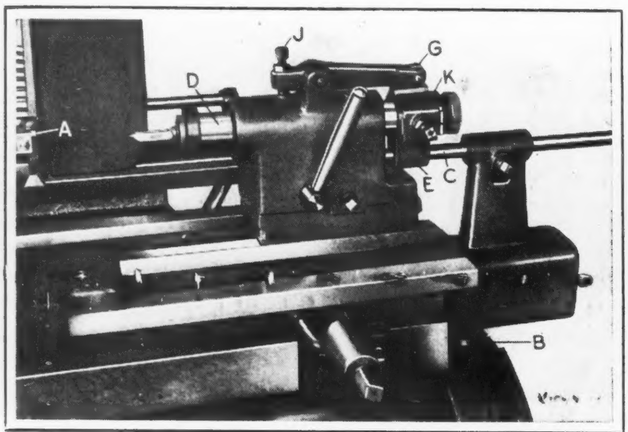


Fig. 23. Tailstock of Automatic Turning Machine

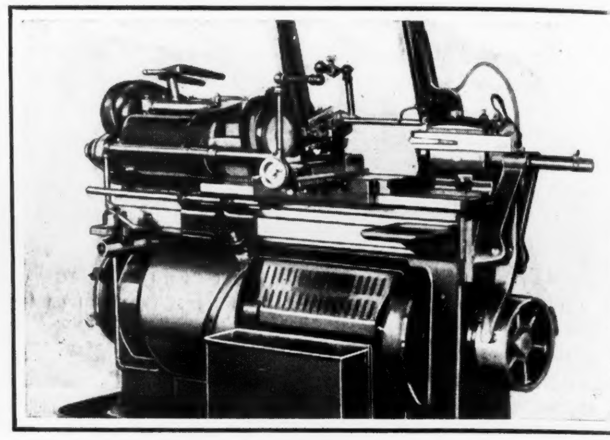


Fig. 24. Automatic Turning Machine

Design of Lathe Tailstocks

Typical Designs for Different Classes of Machines—Last of Three Articles

By FRED HORNER

THE preceding installments of this article have dealt with different forms of tailstocks employed on lathes of conventional design. In the present article automatic tailstocks and tailstocks of special design are described and illustrated.

Automatic Tailstocks

The automatic tailstock shown in Figs. 23 and 25 is employed on a machine built by the Pratt & Whitney Co. With this machine, the work is held in a magazine, as shown in Fig. 23. When the machine is in operation, a piece of work *A* is taken from the magazine, held between centers, turned to the desired shape, and released, after which the same operation is repeated on a new piece of work. The movements of the tailstock spindle required to locate the work on centers and release it after machining are controlled by the cam-drum *B*, which transmits the required movements through the medium of rod *C*. As the piece of work *A* comes into the position shown, the spindle *D* is moved forward by the friction ring *E* attached to rod *C*. The friction grip of ring *E* on the spindle is adjusted by the set-screw *F*, Fig. 25, which presses the pad *P* against the spindle. This adjustment controls the pressure with which the work is held in place between the centers.

When the work is in place between the centers, the friction ring *E* slips along the spindle and continues to move forward until it comes in contact with the roller *G*. Further movement of ring *E* causes the lever *H* to be pivoted in such a manner as to force the pad *I* to lock the spindle in place. The pressure exerted on the spindle by pad *I* is adjusted by means of the screw *J*. When the cut is finished, the cam-drum withdraws rod *C*, releasing lever *H* so that the friction collar *E* is permitted to draw the spindle back far enough to let the work fall from the centers into a box. The collar *K* serves as a stop to prevent the spindle from moving too far.

In Fig. 24 is shown a Pratt & Whitney automatic turning machine having a flat-faced spindle and center that gives sufficient clearance for multiple tools. Provision is also made for adjusting or changing the set-up to machine pieces of various sizes and shapes. The details of this tailstock are shown in Fig. 26. The actuating rod *A* is operated by a sleeve *B* which, in turn, is controlled by a cam-drum through lever *C*. Motion is transmitted from rod *A* to the tailstock spindle by the friction collar *D*. The screw *E*, which is provided with a lock-nut, serves to adjust the pressure exerted on the spindle by the friction pad. When the work is in position between the centers, the friction

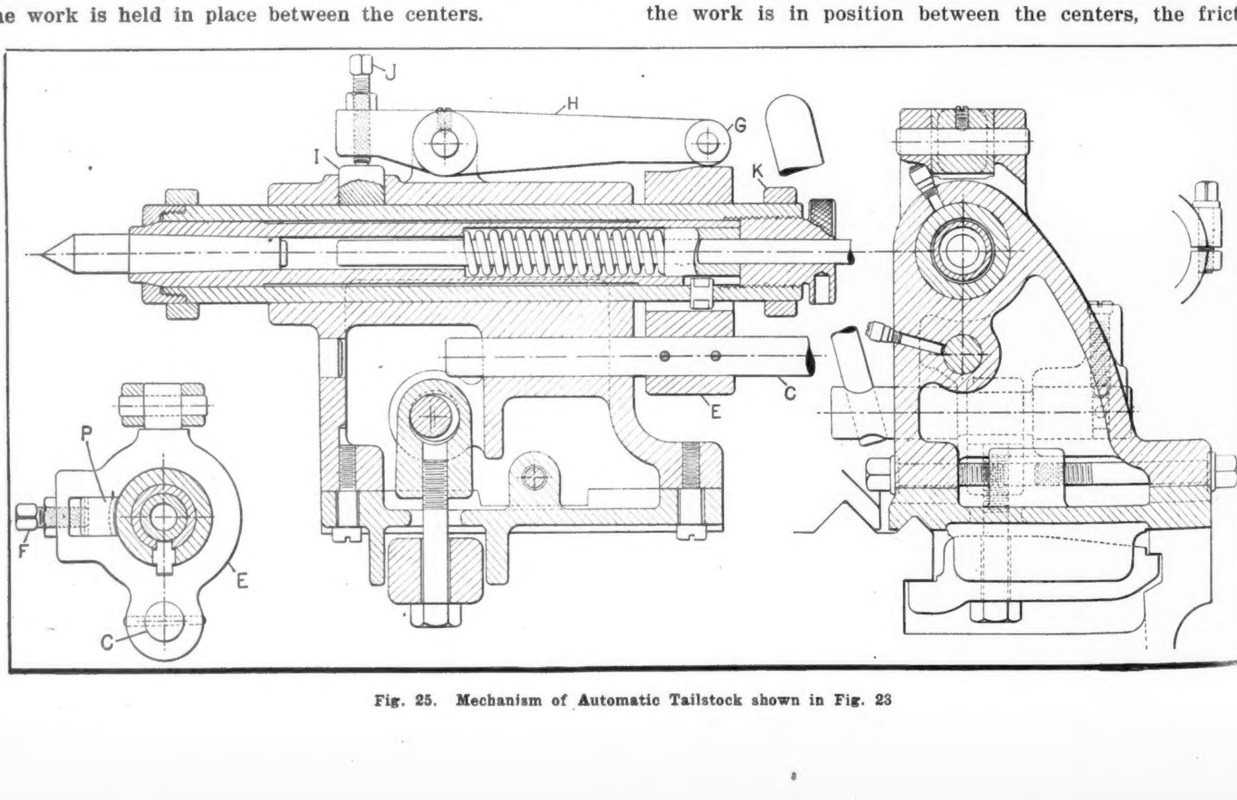


Fig. 25. Mechanism of Automatic Tailstock shown in Fig. 23

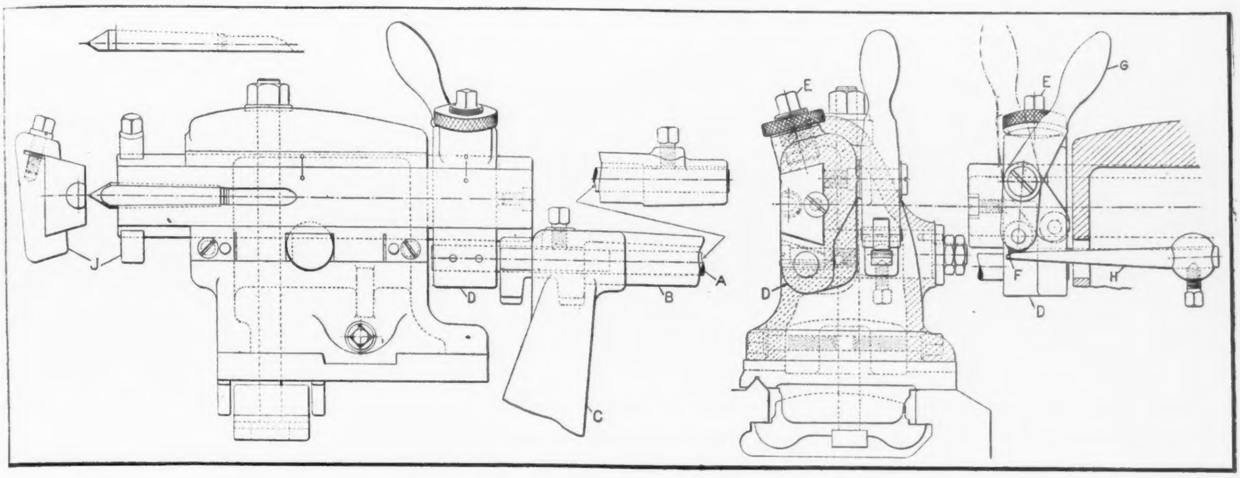


Fig. 26. Details of Tailstock employed on Machine shown in Fig. 24

collar slips along the spindle until the roller *F* at the end of the locking lever comes in contact with the tapered bar *H*. Bar *H* is thus pressed down, tightening the eccentric spindle clamp to which it is attached. The stop-collar *J*, which is clamped to the nose of the spindle, prevents the latter from traveling too far to the rear. The lever *G* is used only when setting up the lathe to bring the roller *F* out of contact with bar *H*.

Bench Lathe Tailstocks

Some interesting types of tailstocks are employed on bench lathes for such operations as drilling, boring, reaming, counterboring, tapping, and broaching. In some designs, a single tool is held in one spindle, while in other designs, several tools are held in separate spindles which are brought into the operating position in successive order. The simplest type of sliding spindle, carrying one tool, is fed forward by simply exerting pressure on a knob at the end of the spindle. A stop-collar is generally provided to limit the feeding movement.

In another design of tailstock, there is a spindle that can be driven at a high speed in a direction opposite to that in which the work rotates by means of a pulley located on the spindle. This combination of two motions results in greater accuracy when drilling deep holes. Some of the sliding spindle footstocks are provided with a clamp suspended from the spindle and fitted to a guide bar which prevents any twisting of the spindle.

There are various methods by which different tools can be made to perform successive operations on a piece of work. Three of the most commonly used equipments are the half-open tailstock, the turret attachment that fits the center hole in the tailstock spindle, and the regular turret tailstock, made with a horizontal barrel and complete indexing mechanism. A less commonly used attachment is the swinging bracket, on which the tools are mounted and brought into the working position by swinging the bracket over. An attachment of this kind may have three spindles, which are brought into position by a latch indexing device. One of the spindles is often provided with a pulley drive.

Tailstocks of the half-open construction are very simple in design, and have only two half bearings, which are lined with hardened steel. The tool-spindle is dropped into the half bearings and simply pushed along. One spindle can be substituted for another very quickly when this arrangement is used. When more feeding pressure is required than can be obtained with the hand-knob, the lever type shown in Fig. 27 is employed. The lever *A* is so designed that it presses on the end of the spindle without being actually connected to it. The hanging clamp previously referred to is shown in this illustration. There is a cross-slot in the spindle of the tailstock to provide for ejecting the tool.

Lever-operated Tailstocks

A tailstock used for drilling operations is shown in Fig. 28. A feeding lever attached to the shaft of a pinion that meshes

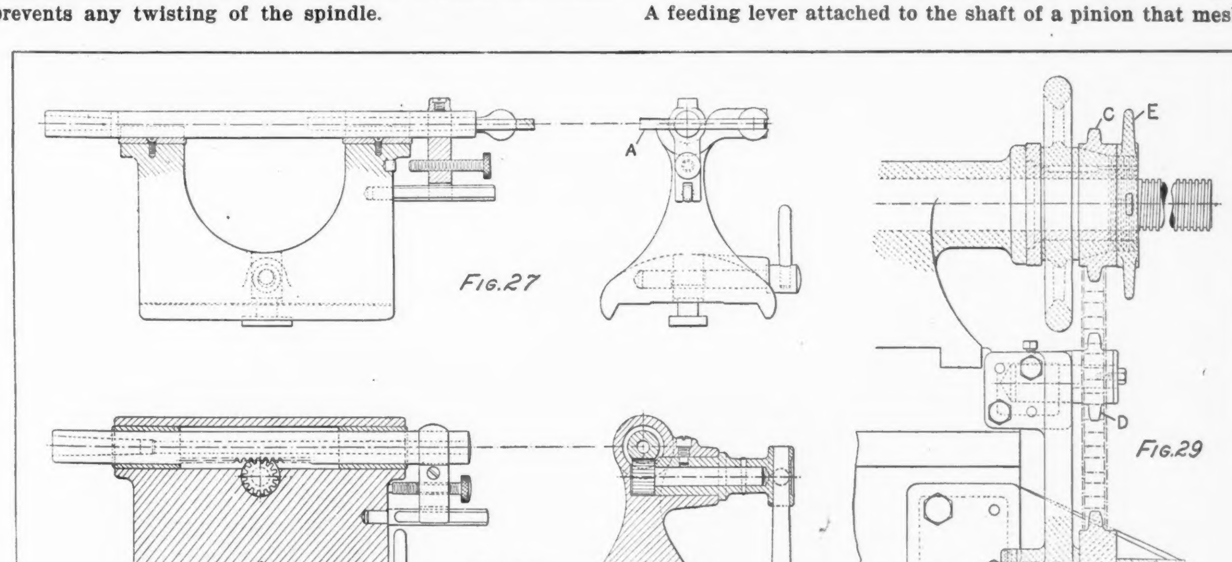


Fig. 27. Half-open Type of Tailstock with Lever Feed. Fig. 28. Tailstock designed for Drilling Operations. Fig. 29. Sliding Head with Power Chain Feed

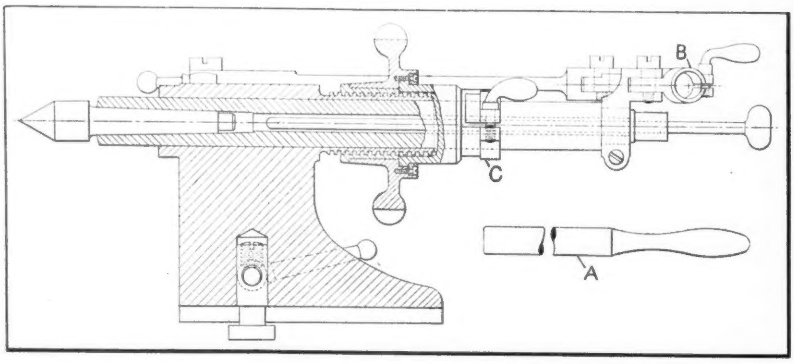


Fig. 30. Tailstock with Combination Lever and Screw Feed

with a rack cut on the spindle serves as the feeding mechanism. A cross-slide base with screw adjustment and micrometer dial can also be added to this form of tailstock. The cross-feed is utilized for boring, recessing, and facing. The combination of screw and lever feed with rapid change to either of these feeding mechanisms is a convenient feature. In Fig. 30 is shown the tailstock of a bench lathe made by the Hjorth Lathe & Tool Co. The spindle can be moved freely back and forth by a hand-lever *A* which is placed in the split clamp *B*. In order to bring the screw-feeding mechanism into operation, the clamp *C* is tightened, causing the handwheel, which contains a nut, to draw the spindle along as the nut advances on the thread.

Tailstocks with Automatic Feeds

On some kinds of lathes, drilling or boring operations are regularly performed by using a loose or sliding head, in which case a power feeding device is supplied. A standard head with a swing of 9 1/2 inches made by Haighs, Ltd., of Oldham, England, which is provided with a power feed is shown in Fig. 29. The feed-shaft *A* is extended, and has a sprocket *B* mounted on its outer end. A chain connects this sprocket with the sprocket *C* on the spindle. The slack in the chain is taken up by the idler sprocket *D*, which is mounted on an eccentric pin that can be rotated and locked in placed when properly adjusted. The sprocket *C* is permitted to run loose without turning the spindle until the winged nut *E* is tightened to clamp the sprocket to the handwheel. The handwheel, in turn, is keyed to the spindle.

A tailstock also built by Haighs, Ltd., is shown in Fig. 31. This tailstock has a spindle 3 3/4 inches square. The feeding mechanism is part of the regular equipment and is driven from the shaft *A*. The worm on shaft *A* drives the wheel *B*, which, in turn, drives the rack pinion *J* that actuates the spindle. End adjustment or feed is obtained by means of the handwheel *H* on the end of the pinion shaft. The spindle has a travel of one foot, the amount of travel being controlled by the stop-rod *C* on which the trip-collar *D* is set as required. When the trip-collar is struck by the bracket secured to the back end of the spindle, lever *E* is thrown forward, causing lever *F* to turn. The turning of lever *F* allows the slide that carries the worm-box to drop, thus disengaging the feed. The box is replaced ready for another feeding movement by means of lever *G*.

Attention is called to the anti-slip dog employed on this tailstock, which is similar in form to that used by this firm for their regular tailstocks. It consists of a vertical plunger *P* with an end designed to engage the rack teeth cast in the lathe bed. By moving lever *K*, the eccentric pin of which fits a slot milled in the plunger, the latter member is raised out of contact with the rack teeth.

Cross-slide Tailstock

An interesting type of tailstock attachment for a brass finisher's lathe is built by Smith & Coventry, Ltd., Manchester, England. The bed of this lathe also supports a slide-rest, a hand-rest, and a chasing arm. The loose head is so fitted to the slide that it can be removed and replaced by a turret. The slide is provided with a cross-feed and stops for use in performing turning and facing operations. A swivel motion is also available for use in taper-boring. Referring to Fig. 32, it will be noted that the base slide is clamped to the bed by a quick-acting toggle and wedge mechanism, and the cross movement is obtained by the large handwheel which is a loose fit on the feed-screw stem.

The back and front faces of the handwheel hub have clutch teeth, and when the handwheel is pulled back, the teeth on one side of the hub engage mating teeth on the feed-screw. Adjustable screws, one of which is shown at *A*, abut against a cylindrical plug *B*, thus serving to stop the feeding movement. When plug *B* is swiveled by means of the handle *H*, which projects through a slot in the body of the tailstock, a hole in the body of the plug is brought into line with the stop-screws. This allows the slide to pass over the stops. This feature facilitates inspecting the work and permits adjustments to be made without disturbing the setting of the stops. When the handwheel is pushed forward, two spur pinions are engaged which drive a splined shaft that, in turn, rotates a bevel-gear. This gearing actuates the rack feed mechanism of the turret when the latter attachment is used. The handwheel at the end of the spindle serves to actuate the feed-screw in the usual manner when the disengaging nut *D* is thrown up into mesh by the handle *E* of the eccentric pin. The lever feed is obtained by means of the handle *F* which turns the worm-pinion *G*.

Double Tailstocks

A few double tailstocks have been built, the McCabe lathe originated many years ago being one of the best known

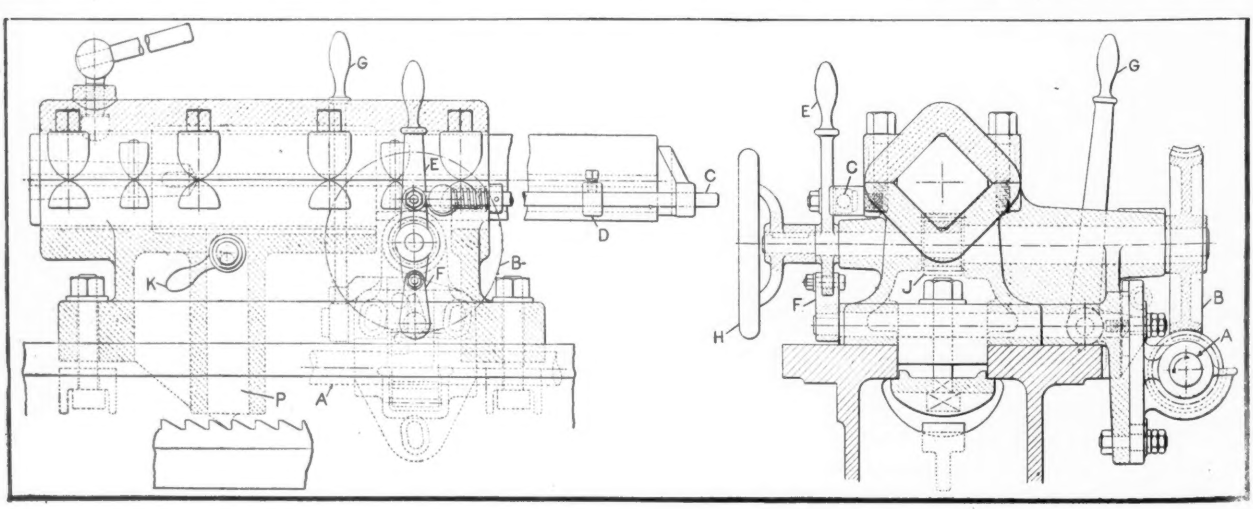


Fig. 31. Tailstock with Square Spindle

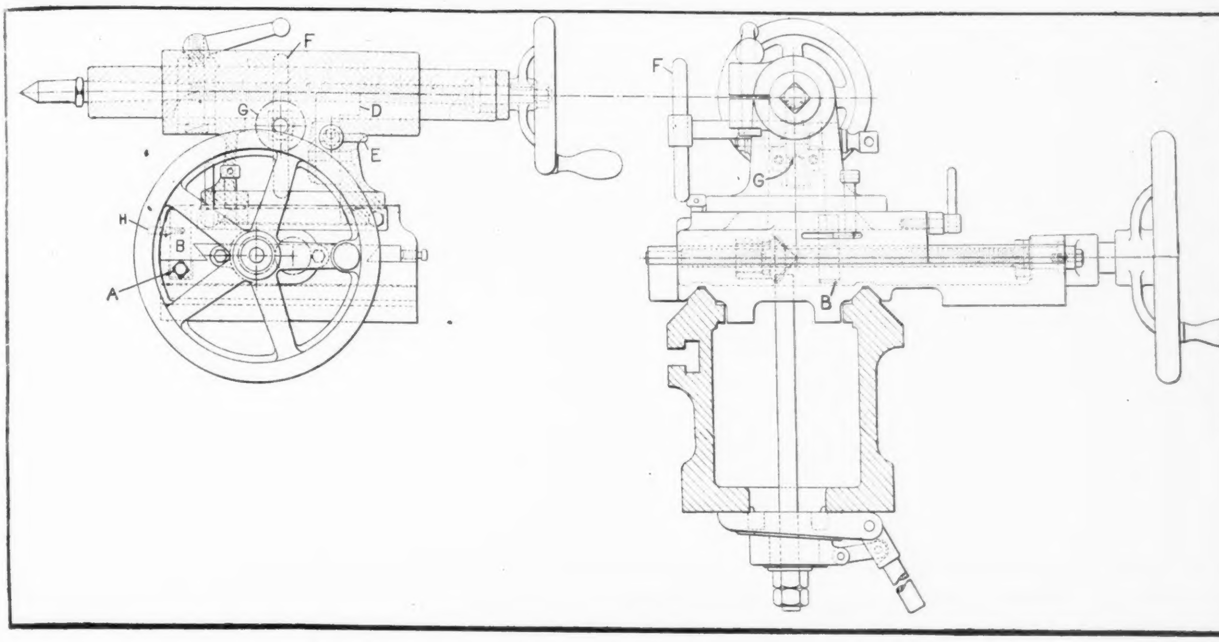


Fig. 32. Tailstock provided with Cross-feed

types having a two-tier tailstock. The lower centers are intended for use in turning small-swing work, and the upper centers for handling larger work without necessitating the use of packing blocks. This type of lathe is desirable for all-around or repair shop work. Another reason for the duplication of spindles and centers was to provide for turning two pieces of work simultaneously.

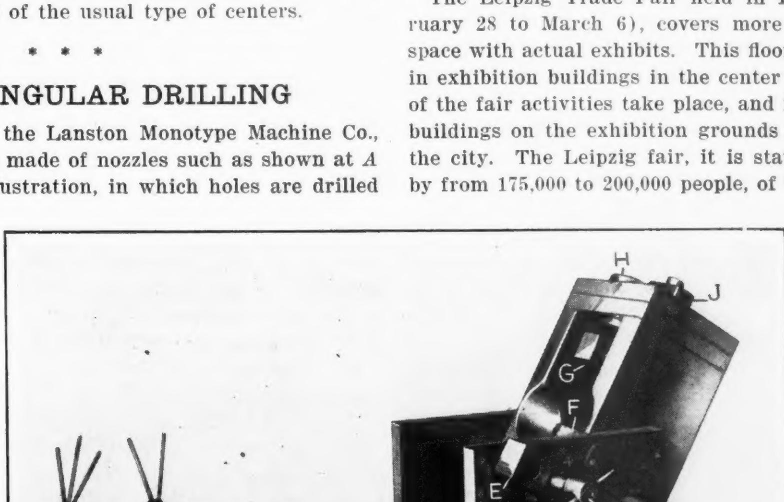
Tailstocks with Work Drive

As a rule, work is driven from the headstock, but some of the shaft-turning lathes have a footstock with a spindle that can be driven by spur gearing from a shaft in the lathe bed, thus enabling long lengths of shaft to be turned without reversing their position between the centers. This design attains a higher development in some of the railway shop lathes where the tailstocks are practically duplicates of the headstocks. These tailstocks often have large jaw chucks, spur gear drives, and occasionally chucks provided with special driving dogs. The head is generally fed along the bed by power, and a handwheel is provided for adjusting the center. In some cases, journal clamping devices are used with both heads instead of the usual type of centers.

* * *

JIG FOR ANGULAR DRILLING

In machines built by the Lanston Monotype Machine Co., Philadelphia, Pa., use is made of nozzles such as shown at *A* in the accompanying illustration, in which holes are drilled at various angles. Three holes are drilled in the left-hand nozzle shown, and two in the right-hand nozzle, as indicated by the positions of the small drills inserted in these holes. The holes range from 0.030 to 0.088 inch in diameter. To facilitate the drilling of these nozzles, the jig shown at *C* was developed. This jig can be set into twenty-four different angular positions by inserting stop-pin *D* through one of three holes in handle *E* and into one of eight holes in one side of the jig body. The tilting range is from 5 to 35 degrees.



Jig used for drilling Holes at Various Angles between 5 and 35 Degrees

Each nozzle is seated in the jig with the lower end resting on the head of screw *F* and with two flats located between two blocks *G*. Screw *F* is adjustable to position the nozzle for height, while the blocks prevent the nozzle from shifting sidewise. A drill bushing such as shown at *B* is made for each job; this bushing has a shoulder that enters a recess in the top of the jig when it is placed in position *H*. Accurate location of the bushing holes for the job is obtained by inserting a pin on clamp *J* into a hole drilled near the edge of each bushing. The drill holes in the bushings are marked in accordance with the holes in the side of the jig into which pin *D* is to be inserted for drilling the holes at the required angles. Hence, it is an easy matter to set up the jig correctly.

* * *

THE LEIPZIG FAIR

The Leipzig Trade Fair held in Leipzig, Germany (February 28 to March 6), covers more than 75 acres of floor space with actual exhibits. This floor space is provided both in exhibition buildings in the center of the city, where most of the fair activities take place, and in machinery exhibition buildings on the exhibition grounds a short distance out of the city. The Leipzig fair, it is stated, is generally visited by from 175,000 to 200,000 people, of whom about 10 per cent are from countries outside of Germany. The number of exhibitors is 13,970, of which 692 are from abroad. The Leipzig Trade Fair has become the largest event of its kind in Europe. Several European countries have established permanent national exhibition buildings at Leipzig. Big trade associations, like the Association of Machinery Builders in Germany, also have their own exhibition buildings.

The Machine-building Industries

PRODUCTION and distribution of commodities continues in large volume. December—the last month for which the Federal Reserve Board's complete index of production is available—shows an advance of 6 per cent in production, which is the highest level in ten months. The iron and steel production increased considerably. The building contracts awarded were the largest ever recorded for that month, and January established another new high record for midwinter building activity. Continued building activity is of the greatest importance in estimating the future trend of business, because the building industry is one of the largest consumers of a great number of raw materials, as well as of the finished products of many branches of industry.

To the extent that the building activity is accompanied by a land boom, it may bring with it results not altogether desirable. According to *Commerce and Finance*, "the national land boom, which has found its most spectacular expression in Florida, continues and attains proportions ominous to economists who perceive the relation between land values and the prosperity of productive business. * * * * * Unsound land speculation has about reached its apex, and we may expect a rapid deflation in the next six to twelve months."

General manufacturing activity, a necessary foundation for good business in the machinery and tool field, has gained remarkably during the last six months, as compared with a year ago. Buying is still on the hand-to-mouth basis, with no marked evidence of a change. Good transportation and a continued effort to reduce inventories to a minimum are the main reasons for the hand-to-mouth buying policy. The general price trend seems to be downward, both according to the Labor Department's and Dun's index figures.

The Atlantic States Shippers' Advisory Board estimates the average volume of business for the first quarter of the year in the eastern part of the country to be about 10 per cent greater than for the corresponding period last year; in the iron and steel field, shipments are expected to show an increase of 25 per cent, in the automotive parts field 10 per cent, and in the general machinery field 25 per cent.

The Machine Tool Industry

In the machine tool field, conditions remain generally satisfactory. Orders booked during January were, in some instances, somewhat less in volume than during the preceding months, but February showed an improvement in several cases, and the decline in January may have been merely a seasonal drop during inventory time. Most machine tool builders state that 1925 has been the best year since 1918 or 1920, and in several cases the volume of business was the largest in the history of the concerns. The industry operates with a more nearly normal force than at any time in the last five years, and in some cases development work has had to be sidetracked to take care of present business.

Dealers who handle both new and used machine tools state that there has been a decided increase in the demand for new machines, as compared with used machine tools—a condition that generally indicates the beginning of an era of active buying, and of increasing both replacement and expansion business. Several leading machine tool builders state that their exports are about 10 per cent of their sales.

Small Tools and Accessories

In the small tool field, the physical volume of business is fully normal, possibly above normal. However, this does not mean that the full toolmaking capacity of the country is required. The tap and die industry, for example, operates as a whole at about from 70 to 75 per cent of capacity. In some instances, big stocks were built up during the period of depression, which have not yet been fully disposed of, and this prevents the plants from running at a percentage of capacity that otherwise would be possible.

The export business in small tools and accessories has increased considerably during the past year. In this field there has been a good deal of business with Russia, twist drills and lathe chucks being among the items that have found a ready market in that country.

In the grinding wheel field, practically every manufacturer finds the volume of business satisfactory. It is estimated that about 80 per cent of the capacity is now occupied.

In the hacksaw field, the volume of business is large, but prices are very low. Although materials for hacksaws are 50 per cent in advance of pre-war prices, and labor is nearly double, hacksaws are being sold below pre-war figures; in fact, some manufacturers state that the prices are far below cost. Instead of an improvement having taken place in this respect during the past year, the prices are lower than ever.

The Iron and Steel Industry

Pig iron production increased 2 per cent in January over December, but at the end of January several furnaces were blown out, so that it is possible that there will be a decline in production in February. Of the 378 available furnaces in the country, 224 were in blast on February 1, compared with 234 on January 1. There is not a great deal of buying for future needs. The steel producers are in a position to promise prompt deliveries, the railroad service is good, and as a result, no one feels that it is necessary to put in large individual stocks. There are no indications of price advances.

One of the most interesting items of news in the iron and steel field is the rumor that the Ford Co. is planning a $250,000,000 steel merger, it being stated that Ford needs have outrun the capacity of the Ford steel plant at River Rouge.

Statistics of international trade show that in the world's steel export field, the United States takes the fifth place, France taking the leading place at the present time. In the malleable iron and steel castings field, the statistics of the Department of Commerce indicate a volume of business considerably larger than the average for the last two years.

The Automobile Industry

The January production in the automobile field is estimated by the National Automobile Chamber of Commerce at 333,700 cars and trucks, compared with 310,240 in December and 231,200 in January last year. It is pointed out that the greater output at the present time signifies better business conditions as well as less caution on the part of manufacturers. In 1924, the dealers were overstocked during the early part of the year. To prevent this, manufacturers went to the other extreme last year; but apparently production is now keeping pace with demand.

The final figures of the Department of Commerce give the production of passenger cars in the United States and Canada in 1925 as 3,817,638 as against 3,262,764 in 1924. The production of trucks was 496,998 as compared with 377,344 in the previous year. Canada's share of the total in 1925 was 139,311 passenger cars and 22,075 trucks. This leaves 4,153,250 cars and trucks produced in the United States in 1925.

The complete statistical records of export for December show that 31,110 cars and 10,410 trucks were shipped from the United States and Canadian ports during that month. This was a new export record for any one month, both for passenger cars and trucks. The figures given do not include the motor vehicles of American make assembled abroad. This gain in exports is considered significant, since December is usually lighter in exports than the spring months.

New Machinery and Tools

The Complete Monthly Record of New Metal-working Machinery

NATIONAL HIGH-DUTY FORGING MACHINES

A number of new features have been incorporated in the line of forging machines built by the National Machinery Co., Tiffin, Ohio, and the capacity, weight, and speed of operation of these machines have been increased. The essential features of previous designs have been retained, such as the short and compact under-slung bed frame; suspended type of heading and gripping slides; patented automatic grip relief; wedge-type liner adjustments for the heading and gripping slides; and friction-slip flywheel.

The bed frame of the new "high-duty" machines has been increased in depth and weight, the new frame being a heavy C-clamp type, which is said to impart a degree of rigidity that prevents springing open of the bed frame, and thereby eliminates swollen shanks, excessive fins, etc., on the forgings. The rigidity also prevents work from slipping through the dies, practically eliminates the necessity for using backstops, and obviates the need of tie-rods. The compactness of the bed frame design, which may be observed in Fig. 1, was made possible by the adoption of a new type of patented, over-arm heading slide, which has only part of its length ahead of the crankshaft, and thus allows a short bed to be used.

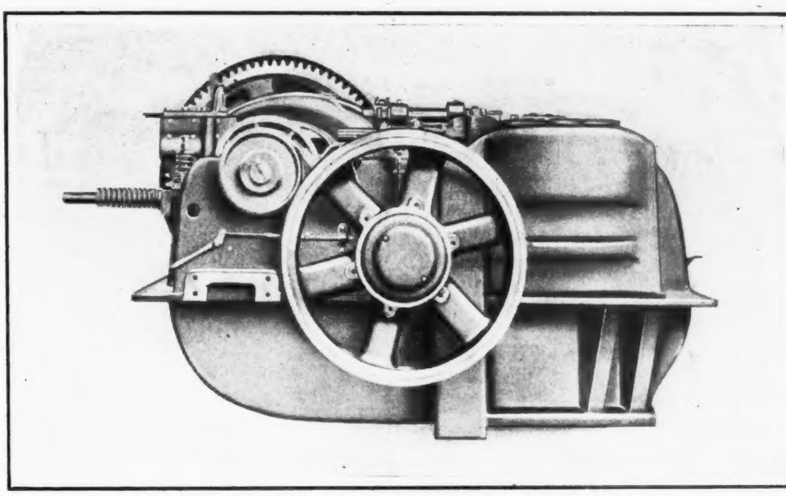


Fig. 1. National Forging Machine of Improved Design

The heading and gripping slides have been redesigned with over-arm or extended bearings, which serve to align the slides accurately. In the case of the heading slide, shown at the right in Fig. 2, this improvement has been accomplished without shortening the tool-holder slot or increasing the length of the bed frame. It is claimed that the design permits the gathering of more unsupported stock in one blow than heretofore, and thus increases the range and serviceability of the machine.

The gripping slide has been provided with an extended under-arm, as shown at the left in Fig. 2, which prevents both sagging and rocking of the slide. By thus maintaining uniformity of the slide alignment, the dies can effectually grip the work through their entire length and prevent the work from slipping. Also, as the dies cannot rock or wabble, no swollen shanks or excessive fins are produced along the body or under the head of the forging. It will be noted in Fig. 2 that the customary knuckle-block at the front end of the heading crank pitman has been replaced by two bronze-bushed bearings in the cheeks of the heading slide. These bearings operate in connection with a large round pin gripped in the front of the heading pitman. This design has increased the bearing area and eliminated trouble from wear caused by scale and dirt getting into the knuckle bearing.

Another improvement consists of an increase in the depth of the die space, which has been made entirely below a center line passing through the crankshaft. It is now possible to use much higher dies than before, without any tendency of the heading slide to rise out of its bearings. In fact, the dies can now extend considerably above the top of the gripping slide and the bed frame without danger of the slide rising and breaking the slide caps, heading tools, etc. This change in the die capacity has greatly increased the range of work that can be handled in the machines.

Another point of interest is that the length of the heading slide enables the downward pressure from the heading crank pitman to hold the front end of the slide in a down position and thereby resist any tendency for the slide to rise when the work is above the center line. All the machines are equipped with the customary National suspended type of heading and gripping slide bearings, which are located above the path of scale and water. The wedge adjustment is at the side of the slides, so that by removing the top cap, side play can be eliminated without removing the slides.

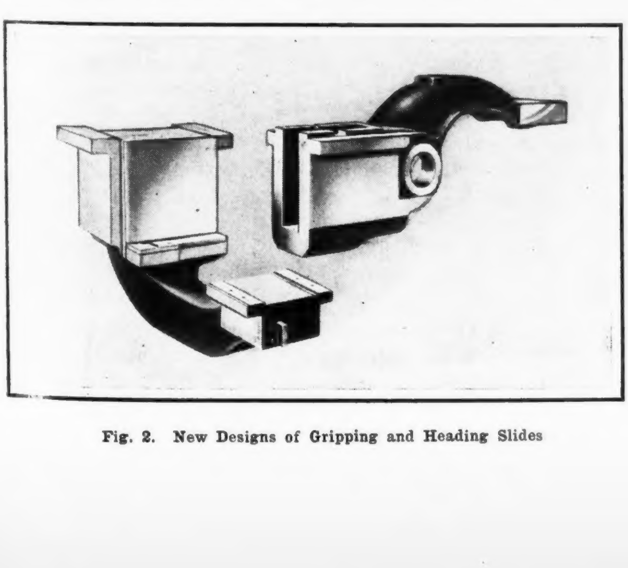


Fig. 2. New Designs of Gripping and Heading Slides

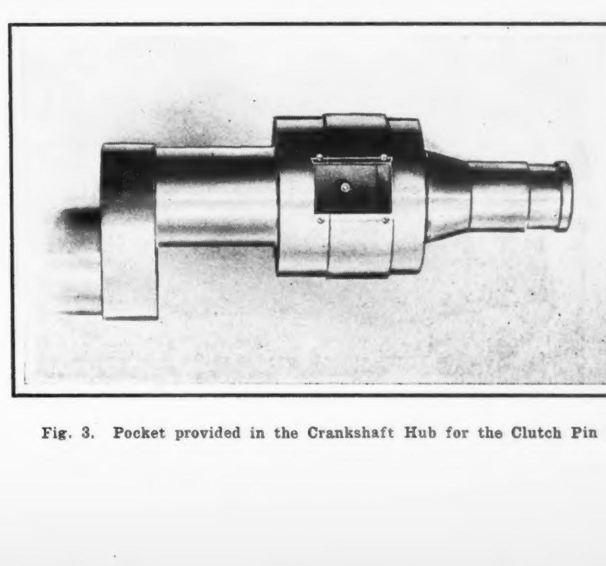


Fig. 3. Pocket provided in the Crankshaft Hub for the Clutch Pin

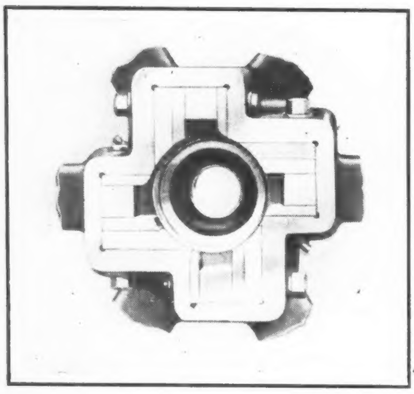


Fig. 4. Quadruple-abutment Starting Clutch

The machines are also equipped with the new quadruple-abutment starting clutch shown in the illustration Fig. 4, which causes the machine to start in one-fourth a revolution. This gives almost instantaneous starting, and is said to result in a marked increase in output and, in many cases, in the elimination of a reheat on jobs requiring a number of blows. Another advantage is less fatigue on the part of the operator, on account of the reduced time that he must hold the stock in position before the gripping dies close. The clutch pin is now a long rectangular member having a large bearing area. It travels in a pocket in the hub of the crankshaft, which may be seen in Fig. 3, and engages hardened clutch-abutment blocks in the main gear. These blocks are backed by laminations to cushion the starting movement and eliminate wear.

The high speed of the new machines, together with the quick starting feature, stiffness of the bed frame, and accuracy of the slide alignment, enables many forgings to be produced that could not be made successfully in the previous machines. Not only is the quality of the forging said to be improved, but the die life is also increased by the elimination of tool interference and spring in the bed frame. The machines are built in 2-, 3-, 4-, 5-, and 7 1/2-inch sizes and may be either belt-driven or direct-geared motor-driven. A friction-slip flywheel is supplied as the necessary safety equipment for the motor drive.

GRANT DOUBLE-END THREADING MACHINE

The modern tendency in the design of "single-purpose" machine tools is to make them flexible or adaptable to a range of work sizes when this does not reduce the operating efficiency or seriously increase the initial cost of construction. This principle has been applied in the design of the improved double-end automatic threading, milling, and drilling machine of the Grant Mfg. & Machine Co., N. W. Station, Bridgeport, Conn. Although this machine is a single-purpose type, it is designed to accommodate a range of diameters and lengths by making simple changes and adjustments.

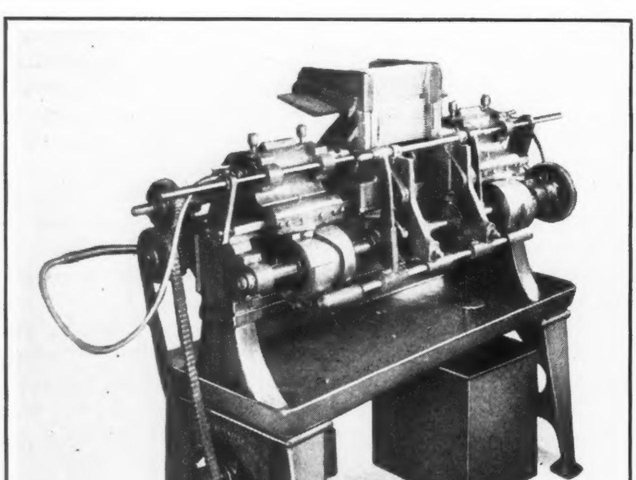


Fig. 1. Grant Double-end Automatic Machine for Hollow-milling, Threading and Drilling Operations

The operations performed by this machine include hollow-milling, threading, and drilling the opposite ends of such parts as rods, spindles, or work of that general character. Both ends are operated upon simultaneously, and one end may be milled while the other is being threaded, or threading may follow as the second operation, as, for example, when both ends require a diameter reduction prior to threading.

The mills, cutters, and dies are held by opposed heads which are moved along the bed, toward or away from the work in the center, by large cams which, as the illustration shows, are at the front of the machine. The rods or other work are placed in the magazine hopper, which has a simple but effective agitator to make each rod roll squarely into the vertical guides. Cam-operated transfer slides convey each successive rod from the bottom of the vertical guides to a position between the clamping jaws. The forward jaw is then advanced by a cam, and when the work is firmly gripped, the tool-heads are advanced. After the ends are machined and the tool-heads have withdrawn far enough to provide the necessary clearance, the machined rod is ejected and the next successive one is placed in the working position. This cycle is repeated for each part, the machine being fully automatic.

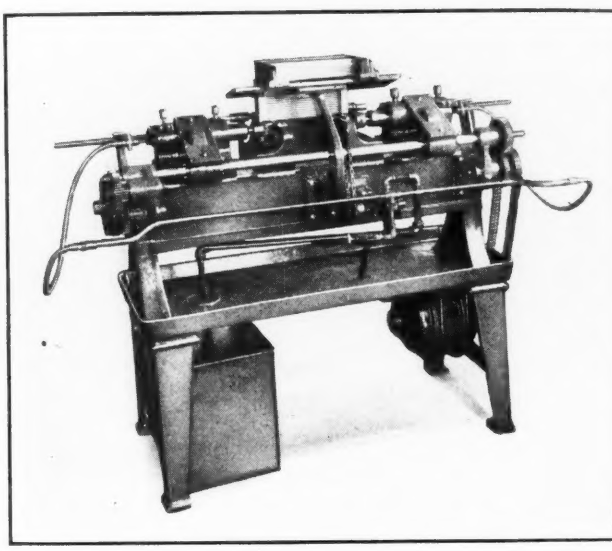


Fig. 2. Rear View of the Double-end Machine illustrated in Fig. 1

The main drive to the spindles is from a two-horsepower motor located beneath the bed. The drive is through a silent chain and two spur gears to a splined shaft in the rear, which, in turn, connects through gearing with the spindles. By changing the two spur gears in the main drive, the spindle speed may be varied to suit different diameters or materials. The main cams that operate the tool-heads may be adjusted along a threaded shaft for locating the tool-heads according to the length of the work.

The particular magazine feed shown is special for one job, but the standard design is adjustable for diameters and lengths within the minimum and maximum range. This machine may be set up for a different operation in about twenty minutes, assuming that the special clamping jaws and cam-plates are at hand. Self-opening dies are used for threading, and these are tripped by adjustable stops which may be seen at the front of each tool-head.

The rate of production varies, of course, according to the size of the work, the kind of material, and the lengths of the cuts. The particular machine shown is for machining the ends of sewing machine pitmans. These rods are 0.285 inch

in diameter by about 12 5/32 inches long, and the first operation consists of turning down each end with hollow-mills, and at the same time facing the ends and drilling a small hole in one of them. The production for this operation is 7 rods per minute. After a lot has been machined, one end is threaded, and for this second operation the production is 24 per minute, the thread being 5/8 inch long, 15/64 inch diameter, and 28 pitch. In cutting a thread, the die is positively advanced by the tool-head cam at a rate equal to the thread lead.

This machine will take lengths up to 16 inches. It is readily adapted to new work by changing the cam strips (and possibly the change-gears), by providing new clamping jaws to suit the shape of the work, and by adjusting the magazine feed and the tool-heads. Lubrication is forced through each hollow spindle from a pump at the rear to keep the tools cool and free from chips. The change-gears have a guard or cover (not shown), as has also the chain drive from the motor. The machine itself is protected against breakage by an ingenious spring and ball detent type of clutch which slips from one position to the next, if for example, a piece should be caught between the unrecessed part of the clamping jaws.

Although the machine illustrated is motor-driven, it may be driven by belt connecting with a pulley which replaces the driven chain sprocket. The machine base is an improved design, and the machine throughout is constructed to maintain accurate alignment of the working parts. One operator can attend to from two to four machines, depending upon the class of work and rate of production.

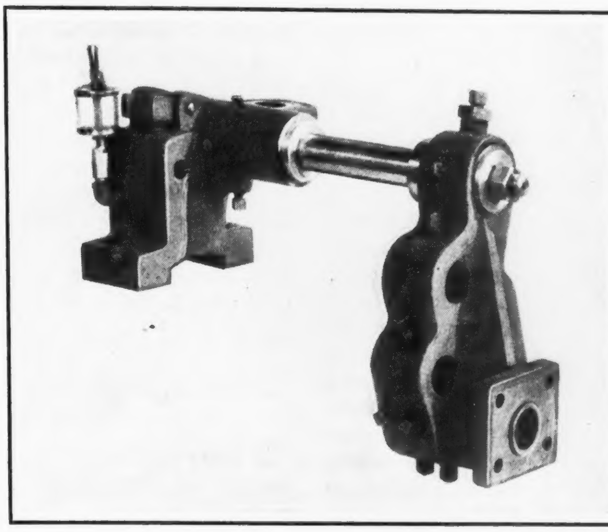


Fig. 1. Warner & Swasey Multiple Turning Head with Overhead Pilot

WARNER & SWASEY UNIVERSAL TOOLING EQUIPMENT

Four tools that are part of an interesting line recently developed by the Warner & Swasey Co., Cleveland, Ohio, for use on the Nos. 1, 2, 4, and 6 turret lathes, are shown in the accompanying illustrations. All these tools are designed with a view to insuring rigidity and making possible multiple and combined cuts. Fig. 1 shows a multiple turning head equipped with an overhead pilot attachment. This tool is particularly suitable for use with small or average lots of medium or heavy work, since heavy feeds can be taken without using special pilot-bars. The important feature of the overhead pilot-bar is a radial adjustment which enables wear of the machine to be compensated for without the need of sacrificing rigidity.

The bar is supported in the multiple turning head by means of four screws which give a four-point bearing for alignment with a bushing in the head of the machine. This construction is patented. After proper alignment has been secured, the bar is clamped firmly by means of a washer and nut on the rear end. The overhead pilot-bar passes into a bracket attached to the front of the head. Only one bracket and bushing are required for each machine, as the pilot-bar of the multiple turning head is adjustable relative to this one bushing.

The multiple turning head itself contains holes that are located at different distances from the center to give an extensive turning range. Cutter-holders of different styles, such as shown in Figs. 2 and 3, are used for turning, boring, facing, and chamfering. Forged boring cutters can be held in the center hole by using the rocker bushing shown. The center hole can also be fitted with stub boring-bars, drills, reamers, pilot-bars, and similar tools. The head is heavy and rigid and is designed to afford suitable tool clearances. It can be quickly set up for multiple cuts, and will handle a wide variety of work up to the turning capacity of the machine.

The multiple cutter-holder shown in Fig. 2 is intended for use in the multiple turning head. It carries two cutters which are adjustable to different positions for turning two diameters at the same time or for turning and facing. Tie-screws and bushings are furnished to prevent the sides from springing apart when clamping the cutters. A variety of holes makes it possible to shift the cutters to different positions to give a number of tool combinations. The holder may be moved in and out of the multiple turning head to suit the range of the cut. The entire holder is hardened and the shank ground and flatted.

The offset cutter-holder shown in Fig. 3 is used in the multiple turning head when the cutter would project too far if used in straight or angle cutter-holders. Better support is thus given to the cutters, which is particularly desirable when using stellite cutters. Slots are machined from the solid to accommodate the cutters, tie-pieces being left between the sides of the holder to prevent the sides from springing. This holder is also moved in and out of the multiple turning head to suit the length of the cuts. It is hardened all over, and the shank is ground and flatted, as in the case of the multiple cutter-holder. The cutter is held in place by two screws.

In order to enable multiple facing and forming operations

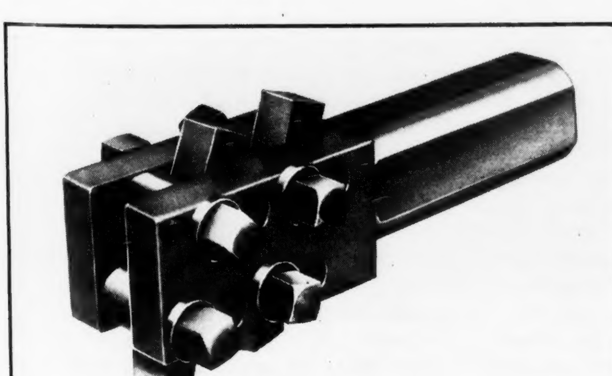


Fig. 2. Multiple Cutter-holder

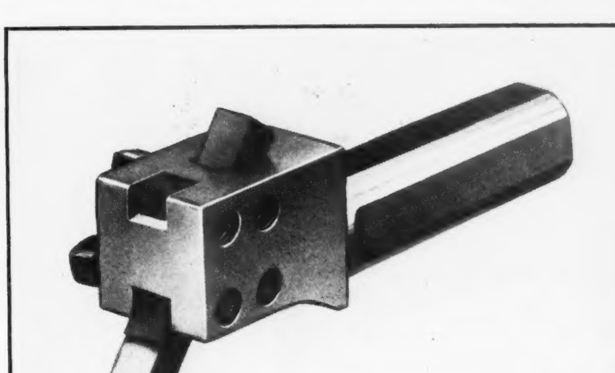


Fig. 3. Offset Cutter-holder

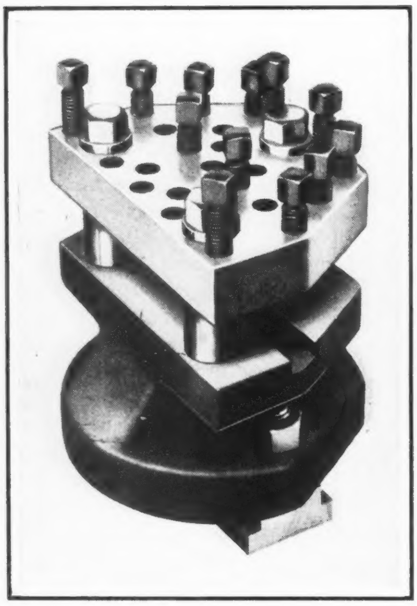


Fig. 4. Cutter-block for Front of Cross-slide

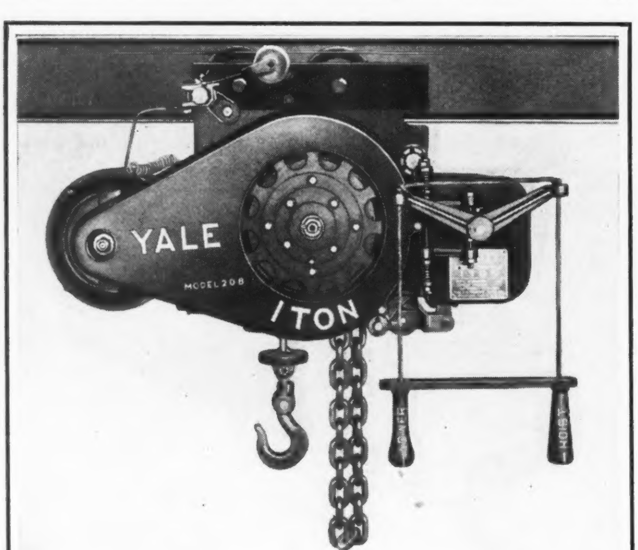
to be performed by means of tools mounted on the cross-slide, it has usually been necessary to make special cutter-blocks and cutters for each job tooled. While the increase in production, especially in quantity lots, soon paid for the extra expense of the special blocks, there is now available the universal cross-slide cutter-block shown in Fig. 4. This device accomplishes the purpose of the special blocks, and may be used for a large variety of work. It is available for both the front and rear of the cross-slide, a rear block being, of course, higher than a front one.

Each block may be set in four different positions on the cross-slide, and the cutters arranged in each of the four positions to give a variety of combinations. Inexpensive forged cutters or bits are used in conjunction with this block, so that in changing from job to job it is merely necessary to regrind and reset the cutters. The block is made entirely of steel and is of rigid construction.

YALE & TOWNE BALL-BEARING ELECTRIC HOIST

A new ball-bearing electric chain hoist, known as the model 20B, has recently been placed on the market by the Yale & Towne Mfg. Co., Stamford, Conn. These hoists are made in sizes ranging from 1/4 to 2 tons capacity. The new model hoist can be quickly adapted to any overhead system, the side plates of the trolley carriage being spaced on steel bars to fit the beam flange. The centralized steel suspension gives a constantly balanced load on the trolley wheels and hoisting unit, irrespective of the position of the load. The mechanism is fully enclosed in oil-tight chambers, and is compact and easily accessible for inspection.

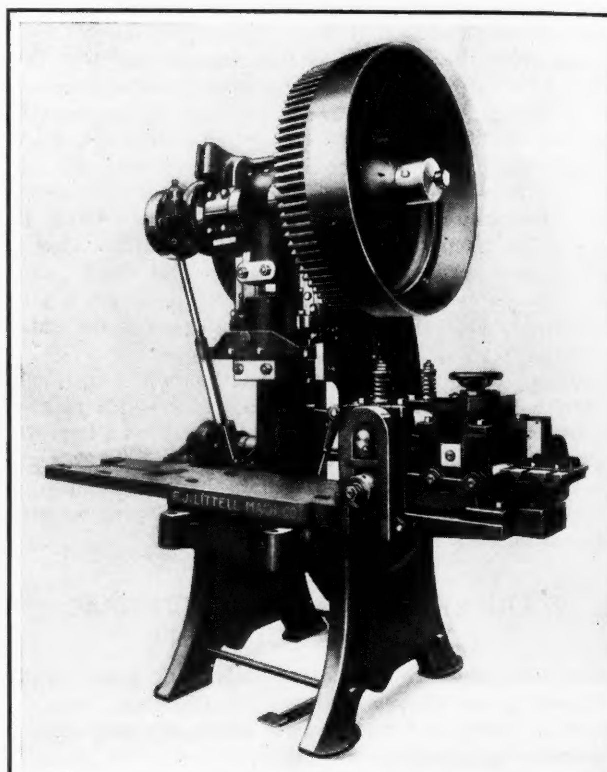
The steel one-piece load sheave is equipped with chrome-vanadium ball bearings, thus reducing the current consumption and increasing the hoisting efficiency. The load sheave is ground on an arbor to insure concentricity for the ball races, and is bronze-bushed for the driving pinion. Splash lubrication provides a continuous flow of oil over all gears, pinions, and bearings. The driving pinion that passes through the load sheave is machined from a single drop-forging and heat-treated. Electrically welded steel chain can be furnished for varying lengths of lift, and steel chain containers are provided to hold any length of slack chain up to 60 feet for the 1/4-, 1/2-, and 1-ton hoists, and 30 feet for the 2-ton hoist. These containers are secured to the under frame of the hoist, and do not affect the head-room.



Yale & Towne Ball-bearing Electric Chain Hoist

LITTELL HEAVY-DUTY AUTOMATIC ROLL FEED FOR PRESSES

A heavy-duty automatic roll feed, which is particularly adapted for blanking hinges and heavy hardware, and is made to fit all makes of punch presses, has recently been brought out by the F. J. Littell Machine Co., 4127 Ravenswood Ave., Chicago, Ill. With this feed, cold-rolled stock 0.137 inch thick by 4 inches wide, as well as stock of No. 14 gage, 8 inches wide, can be handled, in rolls weighing approximately 600 pounds. The stock passes through a power-driven three-roll straightener, which takes out the curvature, and then passes through the feed rolls to the die. The feed rolls are 6 1/2 inches in diameter and 8 1/2 inches wide. They are made of tool steel, hardened and ground. The straightening rolls are also hardened and ground, and are power-driven and connected by gearing to the feed rolls. This attachment is arranged to feed the stock from 0 to 11 inches at each stroke of the press, and although it was originally intended to feed 1/8- by 4-inch stock at 46 strokes per minute, it was found in actual use that the press could be run satisfactorily at 78 strokes per minute with an open belt, using a feed of approximately 6 inches.



Littell Heavy-duty Automatic Roll Feed, which is Applicable to all Makes of Punch Presses

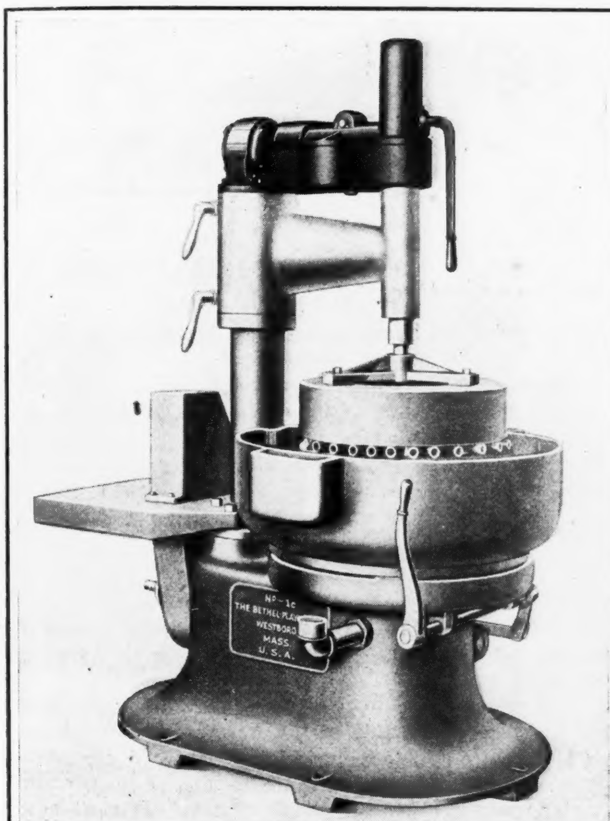
The attachment shown in the accompanying illustration is mounted on a bolster plate, so arranged that a double roll feed and scrap-cutter can be attached later if desired. In the case illustrated, the stock is fed from right to left, and for this reason the single roll feed is on the right-hand side of

the press. Ordinarily, a single roll feed is mounted on the left-hand side of the press, and the stock is fed from left to right.

BETHEL-PLAYER LAP-RAISING ATTACHMENT

A semi-automatic lap-raising attachment has been developed for application to the line of lapping machines made by the Bethel-Player Co., Westboro, Mass. The attachment is shown in the illustration in place on this company's No. 1-C type lapping machine. The device is motor-driven, and has a capacity for the heaviest lap used. It is of sturdy design, with a positive hardened steel clutch and stop mechanism, and is equipped with bronze bearings throughout.

The operation of the attachment is very simple, the operator merely pressing a lever to rapidly raise or lower the



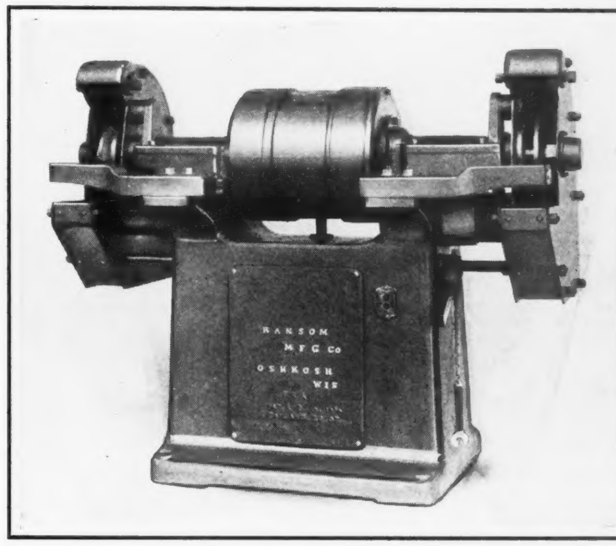
Semi-automatic Lap-raising Attachment applied to a Bethel-Player No. 1-C Lapping Machine

lap, and the action is stopped automatically at both ends of the travel. It will be apparent that this attachment reduces the fatigue of the operator, thereby increasing output and reducing costs. Installations can be made on lapping machines now in use.

RANSOM MOTOR-DRIVEN GRINDING MACHINE

The direct-connected motor-driven grinding machine shown in the accompanying illustration was recently designed for one of the large automobile manufacturers by the Ransom Mfg. Co., Oshkosh, Wis. This machine is equipped with a Westinghouse motor of the direct-current, variable-speed type, the speed of which can be raised 75 per cent above normal, thus enabling the user to maintain a constant peripheral speed until the wheel is worn down practically to the flanges. Instead of being totally enclosed, the motor has provision for a slight ventilation—just enough to avoid excessive heat.

The machine has removable sleeve bearings made of



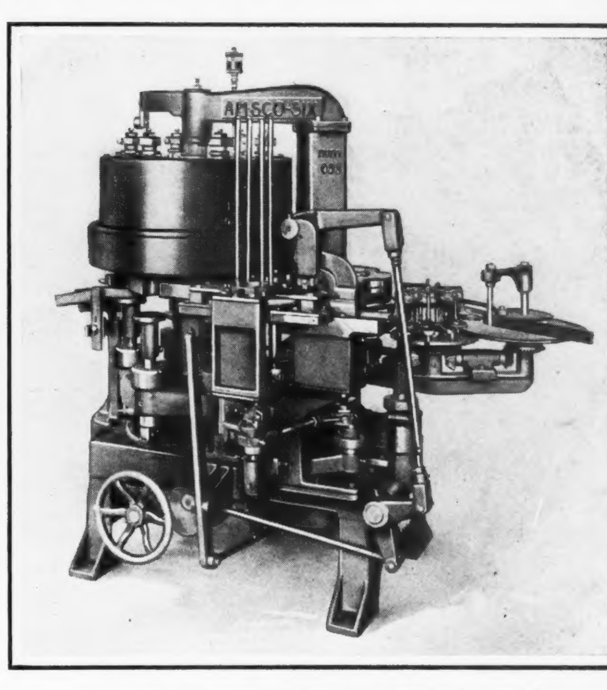
Ransom Direct-connected Motor-driven Grinding Machine

"Lumen" metal, and the bearings are ring-oiling. It is designed to accommodate grinding wheels 20 by 2 inches in size. The wheel guards are made of steel plate, riveted. An automatic accelerating starter operated by a push-button is provided on the front of the machine, as shown. The weight of the machine is 2000 pounds.

MAX AMS HIGH-SPEED CAN-CLOSING MACHINE

A high-speed multi-spindle sanitary can-closing machine, designated as the "Amsco-Six," is the latest addition to the line of can-closing machines made by the Max Ams Machine Co., 101 Park Ave., New York City. This machine is made with a revolving turret having six seaming stations. Each station is equipped with this company's standard seaming chuck and safety ring, and with first- and second-operation rollers, mounted in seaming rings, for making a double seam on the can.

The seaming heads are supported on Timken roller bearings and revolve about six times while the rollers are in contact with the can. Thus, with six seaming heads it can be seen that, in spite of the high output of the machine, the actual speed of each head is less than in the case of a single-spindle closing machine, and each can is in contact with



Max Ams High-speed Multi-spindle Can-closing Machine

the rollers for a longer period. This results in securing tight seams of uniform quality. The can does not move from one chuck to another between the two seaming operations, but remains in the same chuck at the same station for both first and second operations. This obviates danger of "cut-overs" or mashed seams, and prevents the can from slipping on the chuck while being double-seamed.

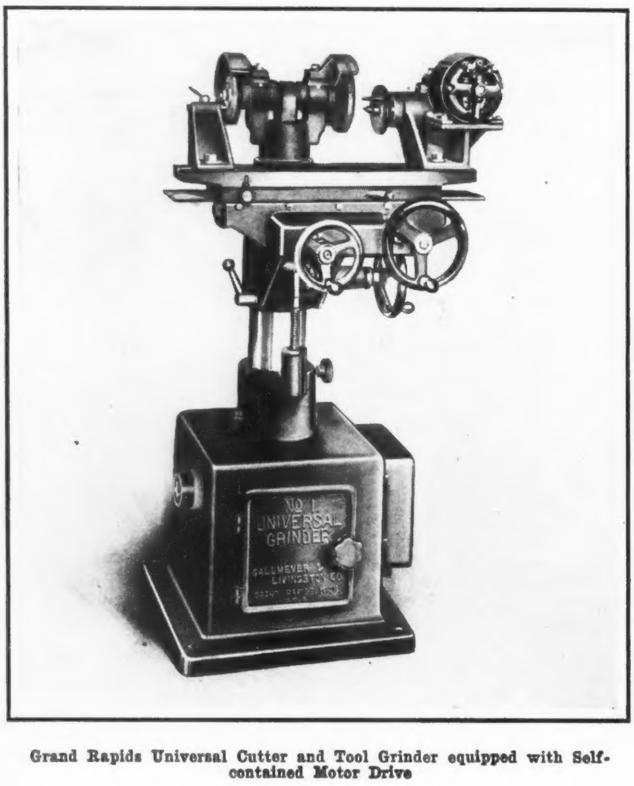
The can feed consists of a revolving disk, which delivers the filled cans to a star-wheel having a series of accelerating separating fingers which sort the cans and deliver them to the seaming stations. The cover feed is very simple. Covers are removed from the magazine by two reciprocating separating knives and transferred to a rotating dial which feeds them to an automatic marking device and thence to the pockets of the intermediate turret.

All the driving mechanism is located beneath the bedplate of the machine, which serves as a shield to protect the mechanism against acid sauces, brine, etc. There is an automatic control which, in the case of a direct motor-driven machine, automatically stops the machine when the covers in the magazine are used below a fixed point.

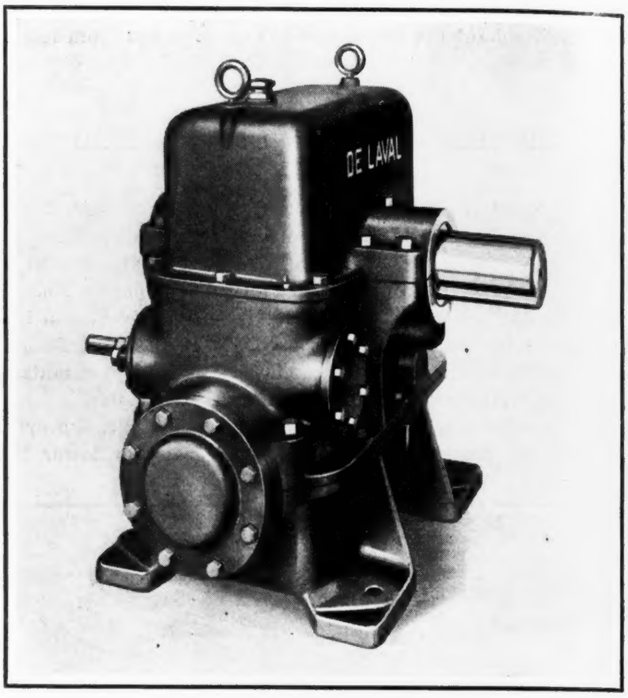
GRAND RAPIDS UNIVERSAL CUTTER AND TOOL GRINDER

The Grand Rapids No. 1 universal cutter and tool grinder made by the Gallmeyer & Livingston Co., Grand Rapids, Mich., has been redesigned with a self-contained motor drive, as shown in the accompanying illustration. In the new design, a 3/4-horsepower motor is mounted in the base, and belted through the column to the grinding-wheel spindle. A swing-door on the base makes the motor easily accessible for adjusting the bearings or cleaning the commutator. A 1 1/2-horsepower lamp socket motor is built into the headstock. The work-spindle is driven by means of a worm, providing the necessary slow speed and eliminating the overhead drum.

Longitudinal, transverse, and vertical movements are controlled by conveniently placed handwheels. A longitudinal movement of 15 inches, a transverse movement of 7 inches, and a vertical movement of 6 3/4 inches are provided. The machine swings work 9 1/2 inches in diameter up to 20 inches wide. All types of cutter, reamer, and tool work that can be handled on standard universal cutter and reamer grinders can be done on this machine.



Grand Rapids Universal Cutter and Tool Grinder equipped with Self-contained Motor Drive



De Laval Two-stage Worm Reduction Gear for Ratios up to 8000 to 1

DE LAVAL DOUBLE-REDUCTION WORM-GEAR

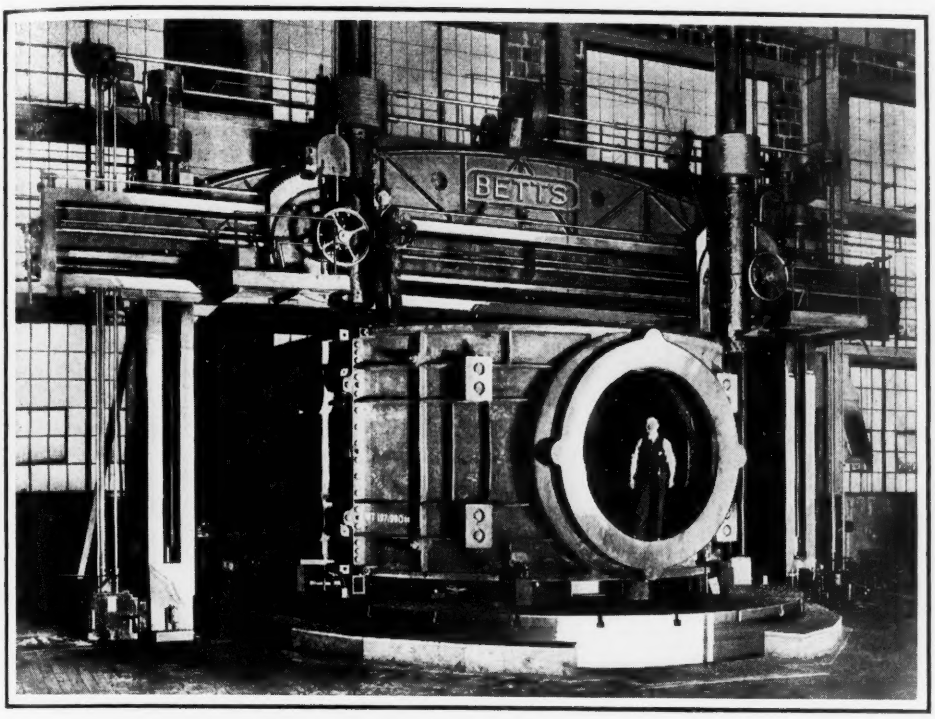
Worm reduction gears, as recently developed for driving slow- and moderate-speed machinery by means of standard high-speed electric motors, give speed reductions ranging from 4 to 1 to as much as 100 to 1 in one step, with satisfactory efficiency. But for ratios above 100 to 1, such as are required for driving cooling tables, conveyors, stokers, heat-treating furnaces, escalators, etc., it is desirable to use two steps, with which the highest reduction ratios ordinarily required are readily attained.

The two-stage worm reduction gear here illustrated has been developed by the De Laval Steam Turbine Co., Trenton, N. J., for ratios up to 8000 to 1. One casing carries all the bearings for the high-speed worm-shaft and the low-speed worm-shaft, as well as for the high-speed wheel-shaft and the low-speed wheel-shaft, thereby insuring accurate alignment and perfect meshing of the worm and wheel in each case. There are only three working members, excluding the ball bearings of the two worm-shafts, and these parts are heavy and rugged. End thrust and bending strains from the driving and driven machine are avoided by the use of flexible couplings of the pin and rubber bushing type.

The one-piece casing also acts as an oil reservoir, the oil being carried at such a height that it constantly touches the high-speed wheel and the low-speed worm. In addition, a positive oil-pump draws oil from the reservoir and forces it through passages to the low-speed shaft bearings. This is an important feature, as it is practically impossible, due to the low speed of this shaft, to lubricate the bearings satisfactorily by splash. Suitable filling and drainage openings and oil-cocks are provided for controlling the oil level. Escape of oil along the high-speed worm-shaft is prevented by a packed gland, while seepage of oil along the low-speed shaft is avoided by the use of an oil slinger working between the end of the bearing and an oil guard surrounding the shaft and held in grooves in the casing and cover.

BETTS LARGE VERTICAL BORING MILL

A large vertical boring mill recently built by the Betts Works of the Consolidated Machine Tool Corporation of America, Rochester, N. Y., is shown in the accompanying illustration machining a 197,900-pound turbine casting. The machine has a 24-foot diameter table; swings work up to 32 feet 3 inches; is 12 feet 6 inches high under the tool-



Betts Vertical Boring Mill of Large Size

holders; has a 10-foot travel of the tool-spindles; and is driven by a 75-horsepower variable-speed motor.

Three mechanical speed changes are provided through enclosed gears, in conjunction with which the 3 to 1 ratio motor gives a wide range of table speeds. All driving gears, including the large table gear, are made of steel. The bed, table, and uprights are all of large proportions, designed to resist the strains of heavy cuts on large work. The cross-rail has metal extending backward between the uprights to provide adequate stiffness, and is reinforced at the top with a wide, heavily ribbed cross-brace. It has a narrow guide for the saddles, and is clamped to the uprights by means of air-operated gibs on the inside and outside of each upright flange.

Each saddle is equipped with a platform for the operator, from which all motors may be controlled through push-button stations. Also, vertical and horizontal feeds, vertical and horizontal power rapid traverses, the direction of either a feed or a traverse, final hand adjustment, both vertically and horizontally, and the quick hand-traverse to the tool-spindles are all controlled from the operators' platforms. Duplicate stationary levers are located on each side of the machine. The tool-spindles can be raised or lowered by hand as well as by power. They can be easily swiveled to suit angular work.

A 24-horsepower motor mounted on top of the machine is used for raising and lowering the cross-rail and for driving the power rapid traverse to the saddles and tool-spindles. Feeds are obtained through sliding gears, an independent feed-box being located on each side of the machine. Forced lubrication is provided for the annular bearings on the bed, by means of a special motor-driven pump, and ample lubrication is also furnished to all the other bearings on the machine.

WHITCOMB-DAMERELL SHAPER AND MILLING MACHINE

A Whitcomb-Damerell portable combination shaper and milling machine has recently been developed by the Reed-Prentice Co., Worcester, Mass., primarily for milling the pockets of steam- and drop-hammer bases. This device follows closely the design of the portable shaper that has been built for several years by the same company, except that it is equipped with an electric drill for driving a milling cutter. The standard drill is of 1 1/4 inches capacity, and runs at 180 revolutions per minute, but this equipment can be furnished to meet conditions.

The milling attachment is adapted to milling the clearance necessary for the shaper tool when using the shaper to re-plane the pockets for the uprights on hammer bases. However, the attachment is sufficiently rigid to take a milling cut up to 1/8 inch deep, and thus makes the outfit suitable for both milling and shaping various classes of heavy work.

Whitcomb-Damerell Portable Combination Shaper and Milling Machine

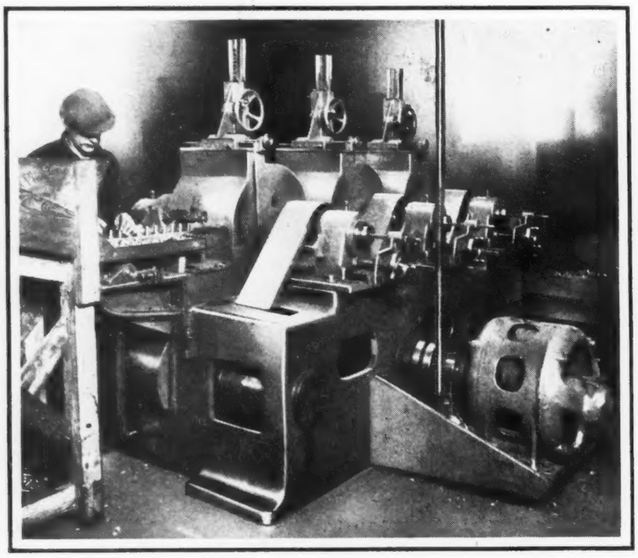


Fig. 1. Gardner Triple-head Disk Grinder designed for grinding Hexagonal Parts

GARDNER TRIPLE-HEAD DISK GRINDER

A new special-purpose disk grinder, designed for the purpose of grinding the hexagonal sides of spark plug shells, but which may also be employed for grinding similar parts, such as hexagon nuts, has been brought out by the Gardner Machine Co., 414 E. Gardner St., Beloit, Wis. This machine is designated as the No. 78 "Triplex." It carries three pairs of grinding members set immediately behind each other, as shown in Fig. 1. These grinding members consist of 20-inch diameter steel disk wheels faced with heavy-type Gardner G.I.A. disks.

The machine is semi-automatic in operation. An endless chain equipped with numerous studs that fit the bore of the parts to be ground brings the work between the grinding wheels. The spark plug shells are placed on these studs by hand, as shown in the illustration, and they are automatically set in the proper position for the first grinding operation. After they pass out from between the first pair of wheels, they are automatically indexed one-third of a revolution, which presents the next two faces to the second pair of wheels. This operation is repeated before the shells enter the third pair of wheels, where the grinding is completed. Following the final grinding, they are automatically unloaded into a container at the rear of the machine, as shown in Fig. 2.

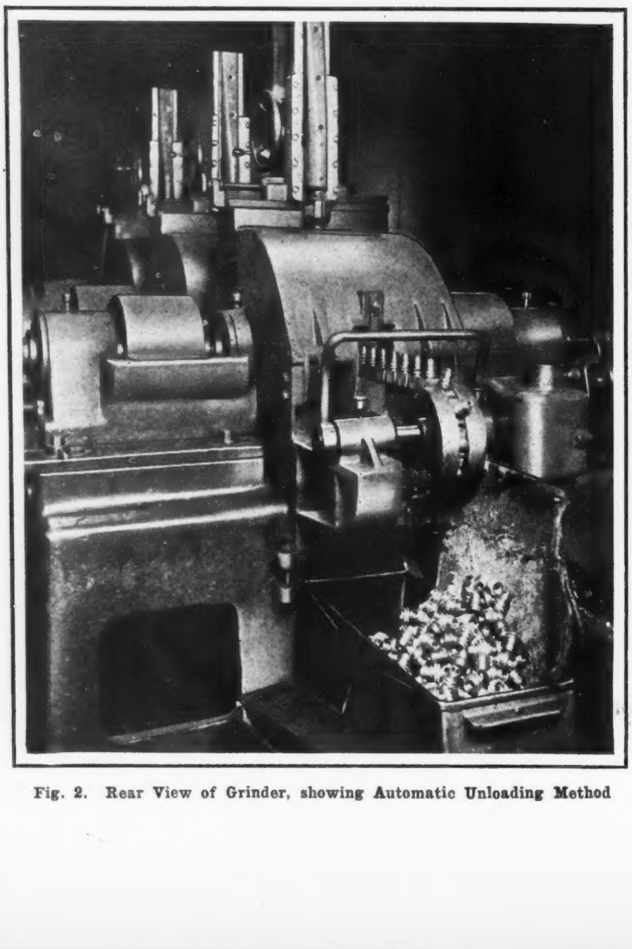


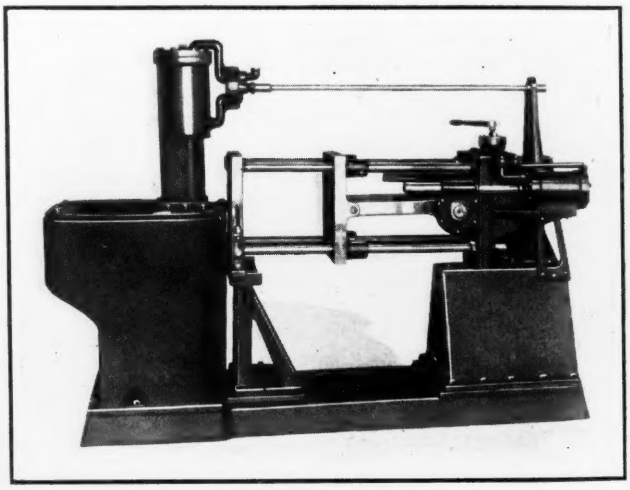
Fig. 2. Rear View of Grinder, showing Automatic Unloading Method

The chain carrying the shells is driven from a jack-shaft in the base of the machine through a worm-gear reduction to secure the proper rate of feed, and is easily and quickly controlled through a friction clutch operated by the hand-lever shown at the front of the machine in Fig. 1. Variation in the rate of feed is provided for. Each of the six spindles of this grinder has under-belt drive. The main drive is through a single 40-horsepower motor, direct-connected by means of a flexible coupling to the main drive shaft, which, in turn, transmits power to the other shafts.

All spindles, as well as the drive shaft, are carried in ball bearings, housed in dustproof housings. The grinding members are carefully hooded, and ample exhaust provision is made. A dressing device is built into each hood, permitting the ready truing up of the grinding wheels. Micrometer stop-screws provide accurate adjustment for wheel wear. This machine is capable of grinding 7000 complete spark plug shells in one hour, with two operators loading.

SIMPLEX DIE-CASTING MACHINE

The die-casting machine shown in the accompanying illustration is an improved design brought out by the Simplex Casting Machine Co., 21152-12th St., Brightmoor, Detroit, Mich. This machine is semi-automatic, air-driven, and uses oil, gas, or electricity for keeping the melting pot at the desired temperature. The operation is controlled by means of two levers, one of which governs the carriage mechanism, and the other the flow of molten metal into the die.



Simplex Improved Die-casting Machine

Dies with several impressions can be used to advantage. The dies are water-cooled to give maximum production and long life, and they are lubricated by the "Alemite" system. Power for moving the die carriage is derived from two air cylinders, one on each side of the machine. These cylinders operate racks which revolve pinions on the two ends of a crankshaft. The crankshaft is direct-connected to the die carriage, thereby sliding it back and forth relative to the stationary die. A patented locking mechanism is provided for the crank.

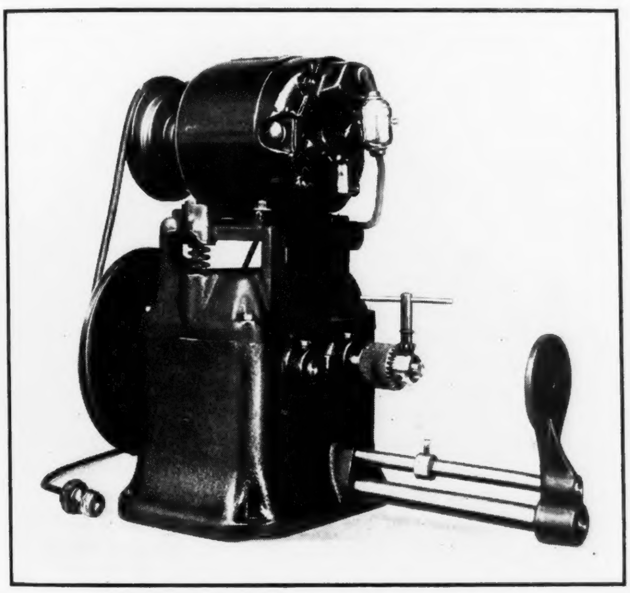
The machine operates at an air-line pressure of from 25 to 100 pounds per square inch, exerting a proportionate pressure of from 500 to 2000 pounds per square inch on the molten metal. The low line pressure greatly reduces the danger of accident, while the high pressure on the metal assures solid uniform castings. The dimensions of the machine are 86 by 26 by 70 inches. The pot has a capacity for 500 pounds of white brass, and castings from the smallest up to 7 1/2 pounds can be produced. From 200 to 12,000 cast-

ings can be made per hour, depending upon the size and design of the casting and the number of cavities in the die. The weight of the machine, crated, is 5200 pounds.

ALTO THREE-SPEED TAPPING MACHINE

A No. 2 motor-driven tapping machine which may be operated at three forward and three reverse speeds to suit taps from 1/8 to 3/8 inch, has been developed by the Alto Mfg. Co., 1647-51 Wolfram St., Chicago, Ill. The machine has ample power to drive a 3/8-inch tap through cold-rolled steel. A special arrangement holds the belt at the proper tension, and changing of the belt to any of the three pulley grooves is quickly accomplished by merely pressing a knob on the left side of the belt. The forward speeds are 150, 300, and 450 revolutions per minute, and the reverse speeds, 300, 600, and 900 revolutions per minute.

The gear mechanism is entirely enclosed, and spur gears are employed. Bakelite gears insure quiet running. A multiple-disk clutch of the automobile type permits the safe use of small taps at high speed and the transmission of sufficient power for using larger taps at a slow speed. The clutch permits tapping to the bottom of a hole without danger of breaking the tap. Two of the motor bearings are wick-oiled, and



Alto Motor-driven Three-speed Tapping Machine

the bearings of the gear mechanism are provided with oilers.

The work is placed on a faceplate, to which jigs can be attached, and pushed against the tap. This engages the driving clutch to feed the tap into the work. When the tap has reached the proper depth, which may be governed by a stop, the operator pulls slightly on the work to engage a reversing clutch, which backs out the tap. The machine weighs about 85 pounds.

COATS CONVERTIBLE BELT GRINDER

A ball-bearing type of abrasive belt grinder so designed that it can be used in either a vertical or a horizontal position, has been placed on the market by the Coats Machine Tool Co., Inc., 110 W. 40th St., New York City. The machine is shown in the vertical position in Fig. 1. It will be noted from this illustration that a table is provided for holding the work when grinding in this position. The upright shown in Fig. 2 supports the abrasive belt and drums.

The drums that support the belt are 3 1/4 and 5 inches in diameter, respectively. They are not ground, but are turned cylindrically, thus insuring sharp edges on the work. Band tensioning is obtained by positive adjustment. Both drums

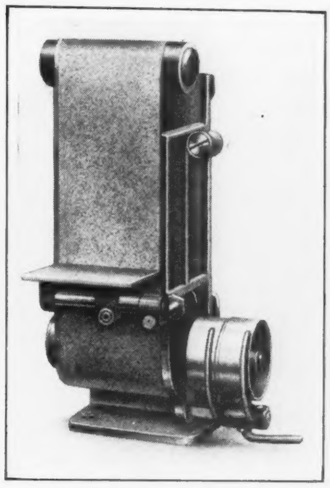


Fig. 1. Coats Convertible Belt Grinder

Fig. 2. Upright that supports Belt and Drums

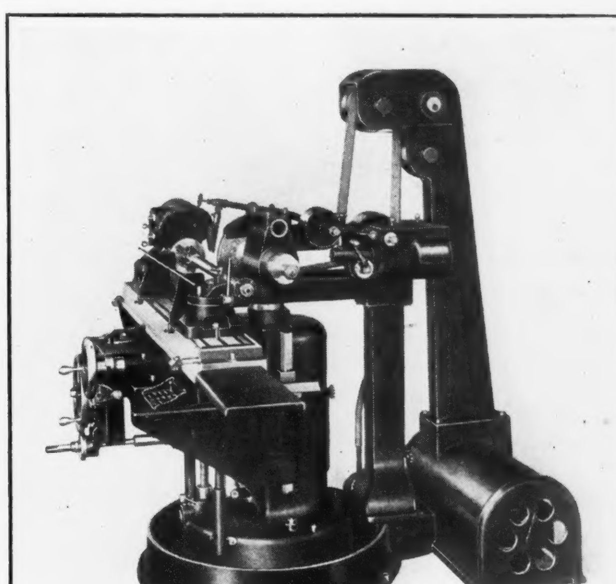
run on ball bearings, and the loose pulley is equipped with double ball bearings. All bearings are protected by dust-proof and grease-packed housings.

This grinder is intended for both roughing and fine finishing operations. It is made in two sizes with belts of 6 by 36 inches, and 6 by 52 inches, respectively.

THOMPSON UNIVERSAL GRINDING MACHINE

An improved 10- by 36-inch universal grinding machine, equipped with self-contained motor drive, has been brought out by the Thompson Grinder Co., Springfield, Ohio. The machine proper is driven by a three-horsepower motor encased in the cage attached to the rear of the machine base, as shown in the accompanying illustration. Power is transmitted by belt up through the box column to the two-step pulley at the top, then down to the driving pulley on the machine and finally to the spindle.

The headstock is driven independently by a 1/6-horsepower motor which is direct-connected. Five work-speed changes are obtainable by means of gears encased in the headstock. The headstock may be swiveled through a complete circle, and so all the flexibility of the ceiling-countershaft type of machine is retained in this improved model.



Thompson Motor-driven Universal Grinding Machine

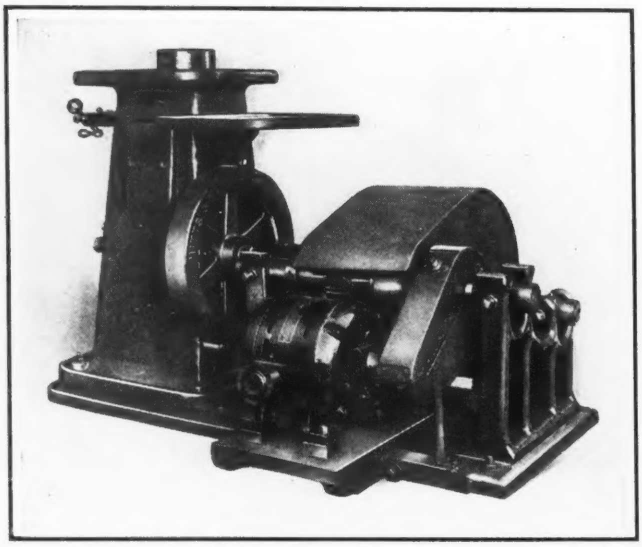


Fig. 1. Giant Keyseater arranged for Individual Motor Drive

NEW DRIVE FOR GIANT KEYSEATERS

The Giant keyseaters made by Mitts & Merrill, Saginaw, Mich., are now provided with two new driving arrangements; the machines may be arranged either for individual motor drive, as shown in Fig. 1, or for belt drive as shown in Fig. 2. The motor drive is through a Link-Belt silent chain to the jack-shaft which carries a spur pinion meshing with a gear on the forward driving clutch. An open belt transmits power to the clutch for the reverse movement. When motor drive is employed, the motor is carried on a plate bolted to the base of the machine, as shown in Fig. 1.

The new belt drive has been worked out along lines similar to the motor drive. As will be seen from Fig. 2, the

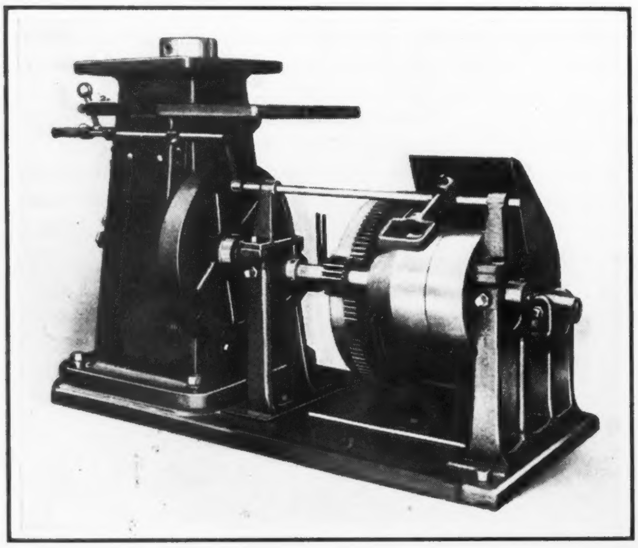


Fig. 2. Giant Keyseater equipped with Belt Drive

tight and loose pulleys are carried on the end of the jack-shaft on which the silent chain wheel of the motor drive is mounted. In other respects, the arrangement is identical with the motor drive. These new arrangements for driving the machine are more compact than the previous design, effecting an economy in floor space and doing away with the overhead works required with the old form of drive.

HEALD "SIZE-MATIC" INTERNAL GRINDER

An internal grinding machine that is fully automatic, with the exception of loading and unloading the work, has just been placed on the market by the Heald Machine Co., 16 New Bond St., Worcester, Mass. In general construction, this machine is identical to the full automatic described in September, 1925, MACHINERY. However, the indicator box has been eliminated, and the sizing device is of an entirely new design and located on the cross-slide. The new machine will automatically grind to size all kinds of holes, whether small, large, straight, tapered, blind, with or without keyways, etc.

After the operator has loaded the chuck and thrown over the reverse lever, the wheel moves up to the work at full speed, then automatically slows down to a roughing speed and a roughing feed, and grinds until the hole nearly reaches the finished size. Next the head automatically withdraws from the work, a diamond drops into place, and the wheel is automatically trued at a truing speed. Then the wheel again grinds the hole, after a finishing speed and finishing feed have been automatically obtained. When the hole reaches the finished size, the wheel automatically withdraws from the work, and all units are brought into a rest position. The

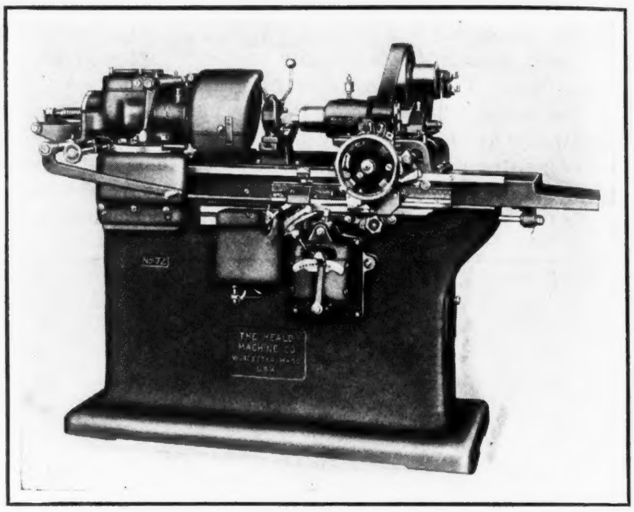


Fig. 1. "Size-matic" Internal Grinding Machine which grinds automatically to the Finished Size

operator then removes the work, and the cycle of operations is completed.

The new method of sizing is controlled by means of the diamond and the cross-slide. As shown in Fig. 2, there is an adjustable ring in back of the handwheel, carrying cam *B* over which points *A* and *C* ride. These points actuate contacts to a magnet box on the front of the machine, which control the movement of the diamond truing device and the bringing of the machine into the rest position when the piece reaches the finished size.

Having set the diamond to true the wheel at a predetermined point in relation to the finished size of the hole, it becomes a positive and simple matter to advance the cross-slide a definite amount (which is controlled by the distance between points *A* and *C*) to secure the same sized hole on

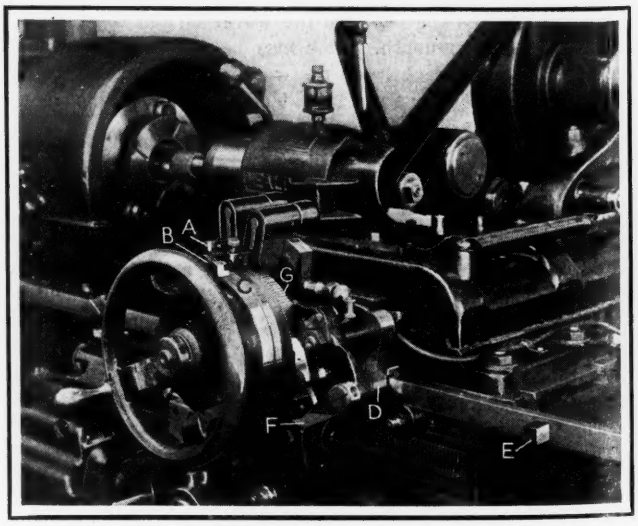


Fig. 2. Close-up View of the Mechanism at the Front of the Cross-slide

each successive piece. This is made possible by the fact that the wheel is trued to present a clean sharp surface for removing a small definite amount of stock.

Cam *B* is a part of the handwheel, and assumes exactly the same position for each successive piece at the time of truing and of finishing. Therefore, the number of passes of the wheel through the work is exactly the same on each piece, and the conditions result in a continuous duplication. There is, however, the factor of wear on the wheel due to grinding and truing, to be considered. If no change were made in the position of the cross-slide relative to the diamond, there would be no stock on the wheel to trim after one hole had been ground, and thus the work would not come to size. To compensate for this wear, the cross-slide is automatically advanced between each successive piece as the table comes into the rest position, by pawl *D* riding over pin *E* to operate pawl *F*. This pawl engages ratchet *G*, which is connected to the cross-slide screw through reduction gears, and thus advances the cross-slide any amount necessary to compensate for wheel wear.

In advancing the cross-slide by this method, the relationship of the cam and the diamond is not changed, and so duplication of the different pieces of work is insured. The machine is said to be as universal as a plain tool, because the sizing is accomplished independently of the work, that is, without touching the work with plugs, gages, or fingers. The "Size-Matic" is easily set up, and because of this, comparatively short runs of work can be handled to advantage.

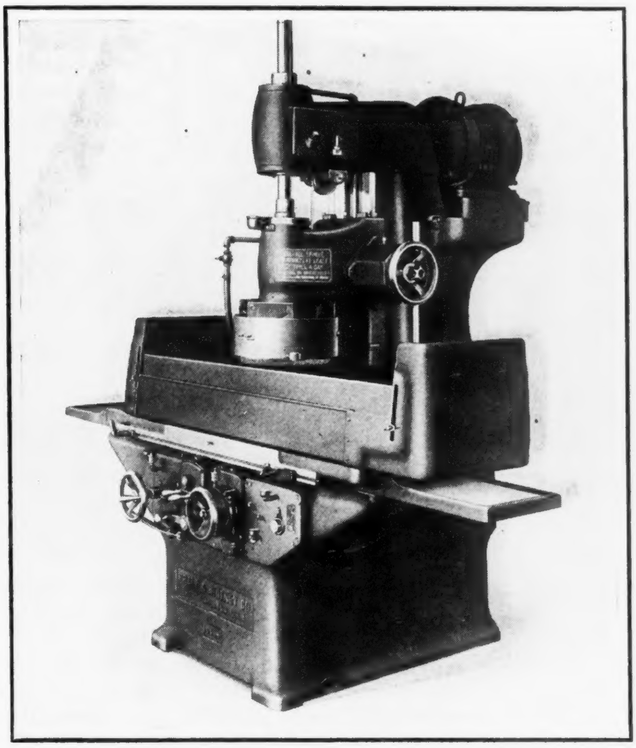


Fig. 1. Pratt & Whitney Model B Vertical Surface Grinder

PRATT & WHITNEY VERTICAL SURFACE GRINDER

An improved model B vertical surface grinder is being introduced to the trade in 14- and 22-inch sizes by the Pratt & Whitney Co., Hartford, Conn., a division of the Niles-Bement-Pond Co., 111 Broadway, New York City. The 22-inch size is furnished with either a 4- or 7-foot bed. The chief improvement in the machine is the method of driving the grinding wheel, as the spindle of the previous model was driven by a quarter-turn belt running from a driving pulley at the rear of the bed up over idlers to a large pulley on the spindle.

The new grinder is motor-driven, the motor being mounted on a bracket cast at the rear of the column top. This motor drives the grinding wheel spindle direct through bevel gears, as illustrated in Fig. 3. The 14-inch machine requires a 25-horsepower motor, running at 1750 revolutions per minute, while the 22-inch machine takes a 40-horsepower motor, running at 1150 revolutions per minute. Either alternating- or direct-current motors can be furnished, together with suitable starting equipment.

In order to mount the motor properly, the entire column has been made heavier and more rigid, and this is also true of the wheel-head and spindle mounting. This stiffening of the machine has resulted in smoother and more accurate action, and the direct-connected motor gives a great increase of power, which makes possible increased production, as compared with the previous model.

The grinding wheel spindle is mounted in ball bearings, which reduce friction to such a degree that the wheel can easily be turned by hand. All ball bearings are protected from dirt and moisture. The grinding wheel is mounted on a faceplate bolted to the spindle, and can easily be removed when a replacement is necessary. A sheet-metal guard protects the operator in case of wheel breakage, and a wheel band provides additional safety.

The wheel-head is counterweighted to permit easy adjustment and to prevent the wheel from sagging. As an additional safeguard against the wheel sagging, the entire spindle is floated on stiff springs, which take up any slight wear that may occur. The wheel-feed controls on the two sizes of machines are essentially the same in principle, but there are some variations to compensate for the difference in size. The 14-inch grinder has a handwheel on the side of the column for rapidly positioning the head, and a fine-feed handwheel on the front of the bed by means of which the operator can bring the work to size by hand adjustment if desired. A ratchet and pawl are connected to the latter handwheel for a power feed operated by the table traverse. The 22-inch grinder has both the rapid- and fine-feed handwheels on the front of the bed, and the same general feed arrangement.

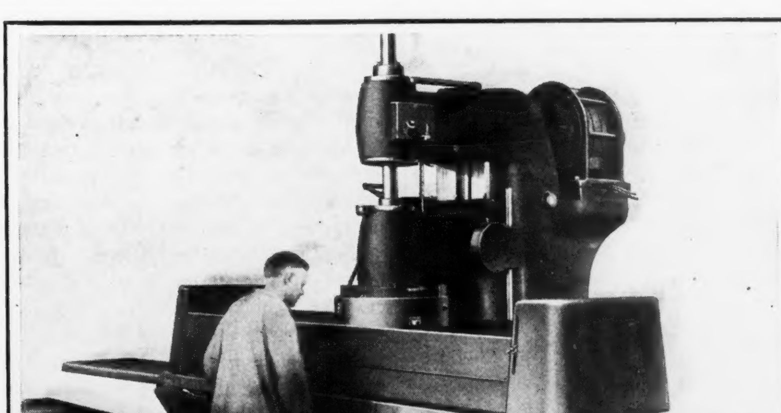


Fig. 2. Twenty-two-inch Size of the Vertical Surface Grinder

The reciprocating table is mounted on one vee and one flat way, and these are oiled automatically by spring rollers running in oil-wells. The solid top of the table protects the driving pinion and rack from grit and moisture, while guards fastened to each end of the table,

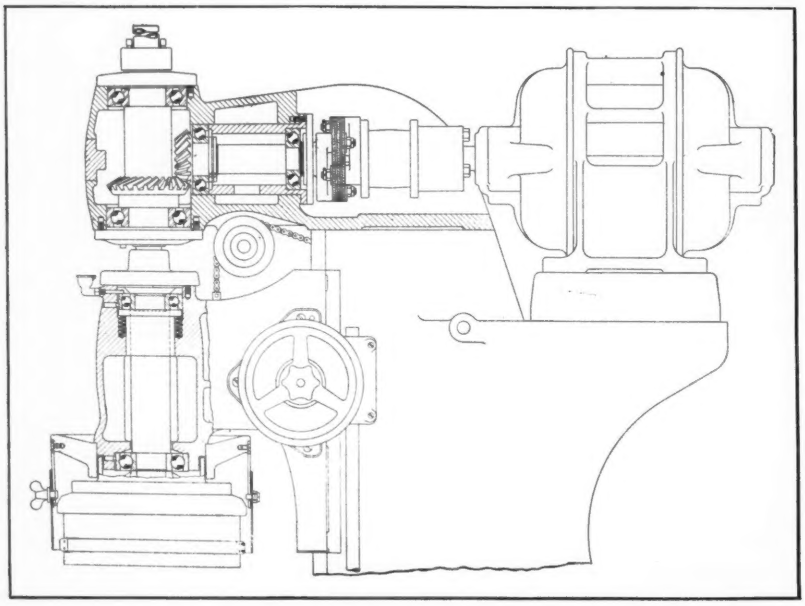


Fig. 3. Arrangement of the Motor Drive to the Grinding Wheel Spindle

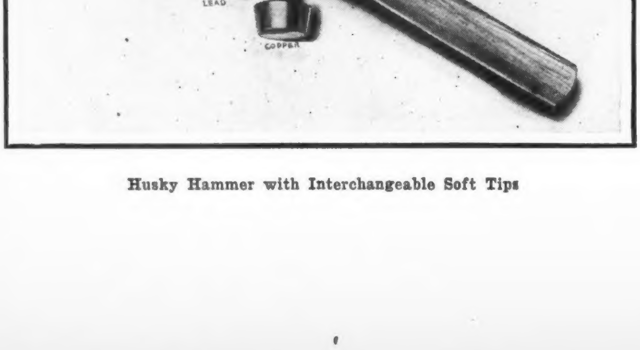
protect the scraped ways of the bed. T-slots provide for mounting magnetic chucks, work fixtures, etc. The length of stroke and the reversal of the table are regulated by dogs adjustable along a T-slot on the front of the table, while a safety dog prevents the table from running off the ways. Two table speeds are provided through a clutch controlled by a handle on the front of the gear-box. The hand movements of the table are controlled by means of a large handwheel, also on the front of the gear-box. This handwheel may be loosened from its shaft by means of a convenient device, so that it will not interfere with the operator when the machine is running.

Cooling solution is pumped through the hollow spindle to the inside of the wheel, and thrown between the face of the wheel and the work to prevent overheating of both the wheel and the work. Solution is also conveyed to the outside of the wheel through an adjustable pipe. Any spray is confined by means of adjustable sheet-metal guards that surround the table.

Both sizes of the machine can be equipped with either rotary or rectangular chucks and plain or magnetic chucks. The weight of the 14-inch grinder is about 9000 pounds, without the motor, and of the 22-inch machine, 16,500 and 19,250 pounds, with the 4- and 7-foot beds, respectively, and without the motor.

HUSKY INTERCHANGEABLE-TIP HAMMER

Sole patent and manufacturing rights have been acquired by the Husky Wrench Co., 928 Sixteenth Ave., Milwaukee, Wis., for the "Everlasting" interchangeable soft-tip hammer

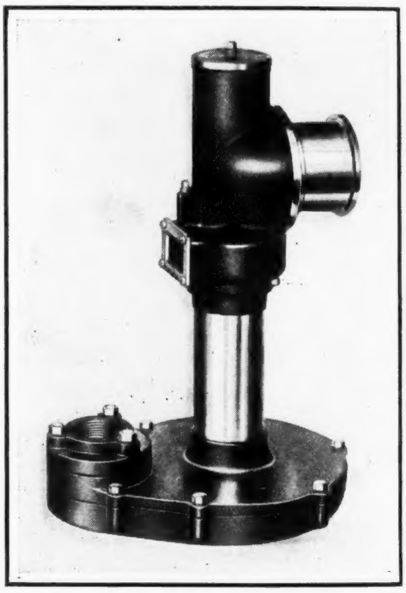


Husky Hammer with Interchangeable Soft Tips

here illustrated. The hammer is made in 2- and 4-pound sizes, with interchangeable tips of copper, lead, rubber, etc. Sets are sold with two tips of each kind or with a selection of tips to suit special use. The tips may be replaced by simply loosening the standard fillister-head screw and holding the two halves of the hammer head together. The hammer is especially intended for the use of toolmakers and die-makers and repair, maintenance, and assembling men.

RUTHMAN REVERSIBLE BELT-DRIVEN PUMP

A model BL "Gusher" reversible belt-driven pump of the design here illustrated has just been placed on the market by the Ruthman Machinery Co., Front and Pike Sts., Cincinnati, Ohio. The housing of this pump contains a vertical and a horizontal shaft, a pair of bevel gears of 2 to 1 ratio, four ball bearings, and an oil-circulating pump. A small auxiliary centrifugal pump located at the lower level of the oil reservoir revolves with the vertical shaft to force oil through a tube into the gear chamber. Here the oil is retained by a disk which is clamped against the inner face of the ball bearing and which extends over the ball race so that the oil may accumulate to a level governed by the overflow. The oil is splashed by the gear teeth to all bearings, and is prevented from working out of the pulley by a by-pass groove in the pulley ball-bearing housing.



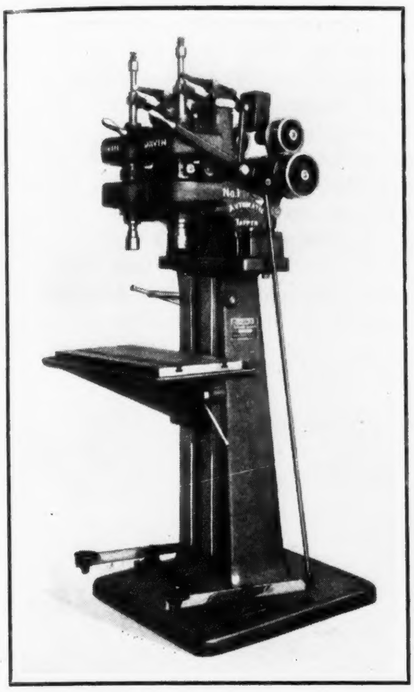
Ruthman Reversible Belt-driven Pump

The window shows the level of the oil in the reservoir and also shows the return stream from the overflow, so that it can be determined at a glance whether or not the oil is circulating. The reservoir holds nine cubic inches of fluid. Liquid cannot rise into the housing when pumping a full stream, or when partially or completely throttled. This is due to the use of a double impeller, the upper half of which is of greater diameter than the lower half and consists of a shallow cup-shaped casting having radial blades within. Each of the compartments formed by the blades communicates to the outside of the impeller by means of holes. The lower half of the impeller consists merely of radial blades.

It is mentioned that small chips and abrasive matter do not affect the pump, because sufficient clearance is provided to permit foreign materials to pass through. The capacity of this pump is 53 gallons per minute with a 4-foot head and running at 400 revolutions per minute.

GARVIN DUPLEX TAPPING MACHINE

Modern methods of production call for machine tool equipment combining rigidity with facility of operation. To fulfill these requirements, the Western Machine Tool Works of Holland, Mich., have improved their Garvin No. 1 duplex



Improved Design of Garvin Tapper brought out by the Western Machine Tool Works

tapping machine, as shown in the accompanying illustration. The tapping heads and driving mechanism of the new machine are the same as in the previous design, the changes having been made in the column, table, and method of adjusting the position of the table and securing it to the column.

From the illustration, it will be seen that the new column is of heavy box section, with provision for housing a counterweight which supports the table by a chain running over a sprocket wheel. The position of the table on the old machine was regulated by a screw, and when it became necessary to change the table position, this method of adjustment consumed a great deal of time. With the present arrangement, it is merely necessary to release the table clamp, and turn a handle connected with the counterweight sprocket wheel.

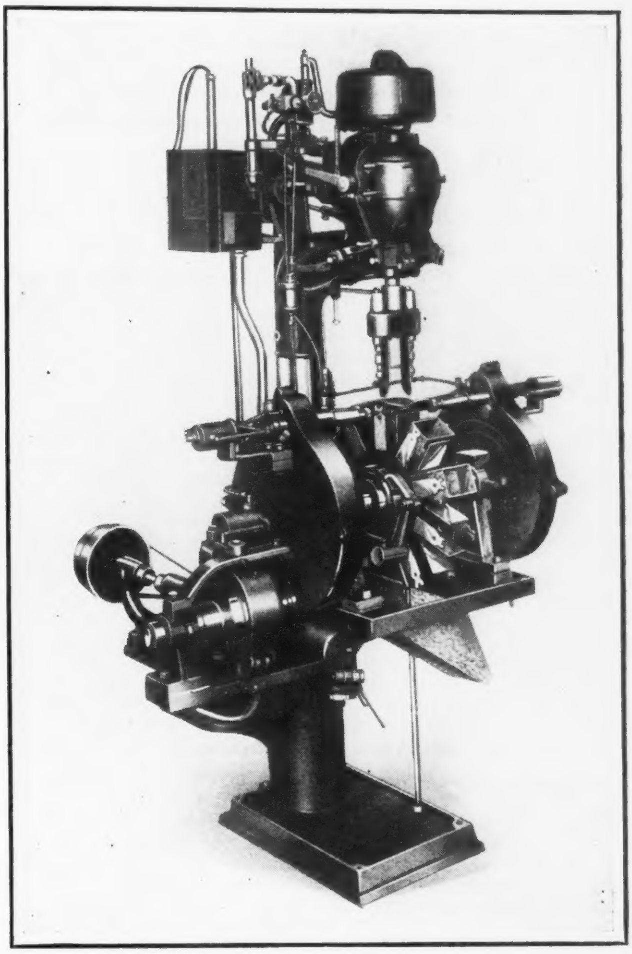
The table is heavily constructed, and is provided with T-slots for securing work-holding fixtures, and with a liberal size oil trough. Under the table there is a Y-shaped web, which provides a knee that it both light and rigid. The table is secured to the V-bearing on the column by means of a screw, which pulls a tapered clamp up against the back of the V-bearing, affording a rigid locking mechanism.

BUFFALO BENDING ROLL

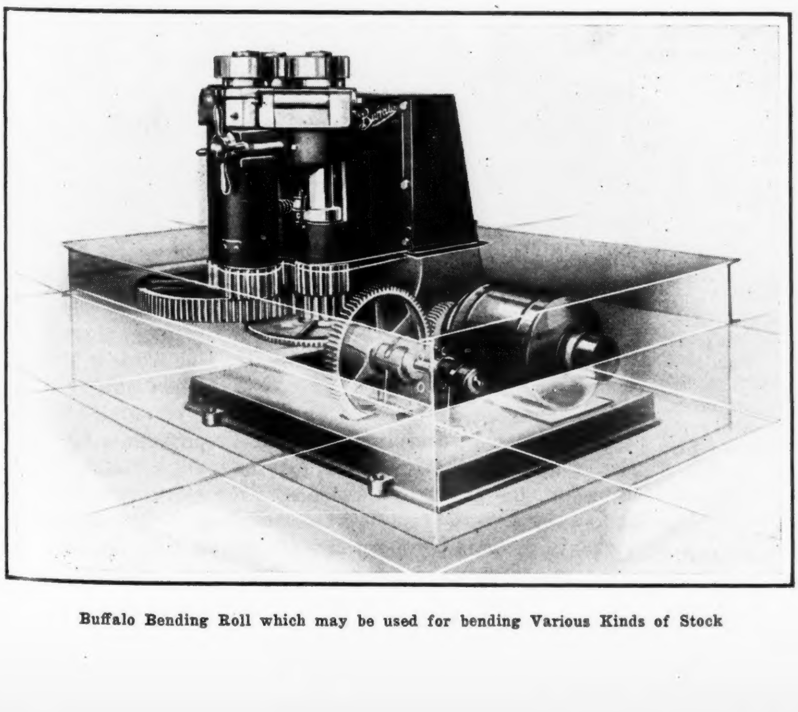
A No. 1 horizontal bending roll recently built by the Buffalo Forge Co., 144 Mortimer St., Buffalo, N. Y., for the General Electric Co. for bending flat bars on edge to various diameters, is shown in the accompanying illustration. The rolls are arranged vertically so that the material is worked on in a horizontal plane. Rolls used on other Buffalo benders can also be furnished for this machine. By using additional rolls, it is posible to bend angle-irons with the leg in or out; T-irons with the leg out; square stock across flats or corners; round or twisted bars; flat bars, crosswise or edgewise; rails; copper tubes of No. 12 or 16 gage; steel pipe; I-beams on the web or flanges; and channel irons with the flanges in or out.

The machine is mounted on a cast-iron baseplate, which is placed at the bottom of a pit 16 1/2 inches deep. Ten-inch channel irons, placed on the floor, support a 3/8-inch checkered steel plate that surrounds the machine. This gives a platform 10 inches above the floor line and locates the rolls proper 36 inches above the floor line. All gearing is concealed. The machine is driven by a 10-horsepower reversing motor through direct gearing. Lubrication of the motor and the main drive-shaft is taken care of by ring-oiling bearings which require infrequent attention. All other parts of the machine are fitted with Alemite connections.

Flat bars, 2 by 5/8 inch in size, have been bent edgewise in this machine into rings having an inside diameter of 13 1/2 inches. The maximum adjustment of the rolls required for any diameter of work is only 1 3/4 inches. This adjustment is made by revolving the capstan wheel at the front of the machine, and is easily effected by one man.



Gaterman Pneumatic Oscillating Tapping Machine arranged for Automatic Operation



Buffalo Bending Roll which may be used for bending Various Kinds of Stock

GATERMAN AUTOMATIC TAPPING MACHINE

An automatic machine recently built by the W. Gaterman Mfg. Co., Franklin and 15th Sts., Manitowoc, Wis., for tapping

switch boxes, is shown in the accompanying illustration. The only work required on the part of the operator is to load the parts into a feeding device in which they are automatically clamped. After the operation has been completed, the work is automatically ejected. Two holes are tapped in each side of the switch boxes by means of horizontal spindles and two holes are tapped in the top by means of vertical spindles. The holes are No. 8 with 32 threads per inch. To safeguard against breaking taps or stripping threads, the machine is equipped with the pneumatic oscillating arrangement provided on other machines built by this company, which have been previously described in MACHINERY. The switch boxes are tapped at the rate of 2000 per hour. It will be apparent that machines of this type can be adapted to a wide range of work for tapping one or more vertical or horizontal holes.

NEW MACHINERY AND TOOLS NOTES

Pantograph Engraving Machine: C. F. Williams Engraving Machine Co., 38 Chardon St., Boston, Mass. A small compact pantograph machine for engraving letters, designs, dies, and similar work up to 3 1/2 by 6 inches. The cutter-spindle is a standard Rivett head fitted with draw-in collets to hold tools up to 1/4 inch in diameter. The work-table is 6 by 8 inches, and has a vertical movement of 5 inches. An adjustable stop limits the upward movement of the table, so that the work can be lowered from the cutter and returned to a predetermined position by depressing a treadle. The pattern table measures 9 by 15 1/2 inches, and can be adjusted in both directions.

Large-bore Grinders: Hutto Engineering Co., 515 Lycaste Ave., Detroit, Mich. A machine intended for wet-grinding cylinders of large bore, which is particularly useful in locomotive building or repair shops where it can be attached directly to the cylinder or piston-valve chamber to be ground. The machine is of double-end type, and employs a tool consisting of a central driving head having six stones at each end. Each stone is 6 inches long, and is set into a die-cast metal holder. The holders are arranged radially and equidistantly from each other. The over-all length of the tool is less than one-half that of the bore, so that an overlapping of the stone travel in the two ends is obtained.

Automatic Milling Machine: Hartford Special Machinery Co., Hartford, Conn. A milling machine designed for the rapid production of parts within a limited range of sizes. The casting upon which the head is carried is pivoted on the base so that it can be tilted to allow the cutters to clear the work during the return movement of the table and thus avoid marking the work. The tilting is accomplished by means of a cam on the table drive-shaft and occurs at the end of the cutting stroke. The table is actuated by the cam that governs the amplitude of the stroke. This cam may be interchanged with others of different contours so as to permit a variety of table movements—uniform, accelerated, or intermittent, as desired. The machine weighs about 2000 pounds.

Grinding and Polishing Machines: Roth Bros. & Co., 1400 W. Adams St., Chicago, Ill. A complete line of pedestal and bench machines for general grinding and polishing. Motors for either alternating or direct current are mounted inside the housings. The bearings of the motors are set forward from the center line to provide greater clearance for work projecting beyond the wheel. Covers permit access to the motor and starting apparatus, which is also located in the base. In power, the direct-current pedestal polishers range from 3 to 8 horsepower, and the direct-current pedestal grinders from 2 to 5 horsepower, while the alternating-current pedestal polishers range from 1 to 10 horsepower, and the alternating-current pedestal grinders from 3 to 7 1/2 horsepower. There is also a 1/2-horsepower bench-type direct-current polisher.

High-resistance Pyrometers: Taylor Instrument Companies, West Ave. and Ames St., Rochester, N. Y. A single-record pyrometer, bi-record pyrometer, automatic pyrometer controller, and wall-type indicating pyrometer. The two recording instruments are similar in construction, the bi-record pyrometer consisting essentially of two instruments under one cover and employing two independent millivoltmeter movements. The charts give a continuous record for 1200 hours, and are divided into twenty-four-hour periods. The indicating pyrometer is a pivoted-coil instrument containing a reflecting mirror that prevents errors in observation due to parallax. The pointer is of the target and knife-edge construction. The automatic pyrometer controller is essentially an indicator equipped with a temperature control apparatus and, optionally, a signaling device.

DISK-GRINDING CONDUIT BOXES

In grinding the flat open side of cast-iron conduit boxes to suit a cover plate, a production of 7200 boxes per hour is obtained with the machine illustrated in Figs. 1 and 2, attended by two operators. The machine is a No. 29 53-inch vertical-spindle disk grinder built by Charles H. Besly & Co., 120-B N. Clinton St., Chicago, Ill. It is equipped with a special fixture having four sets of guides in which the castings travel automatically from one side of the machine to the other. Conduit boxes of 1/2-, 3/4-, and 1-inch sizes are handled, and they are ground as they come from the foundry, to remove all fins and produce a level surface for the cover.

Fig. 1. Semi-automatic Disk-grinding Operation on Small Castings

The special fixture consists of two yokes which are attached to the outer guard-ring support. Fastened to these yokes are eight adjustable channel irons which form four sets of work guides across the top of the disk wheel, as may be seen in Fig. 2. At the top of each pair of work guides, and extending across the face of the grinding disk, is an adjustable spring pressure bar, which is set to regulate the pressure on the work as it passes across the disk.

Feeding devices are mounted on both sides of the machine directly in front of each pair of guides, and driven by belt

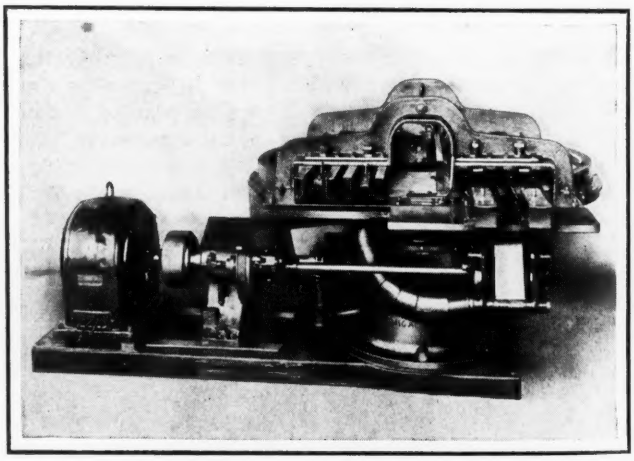


Fig. 2. Arrangement of the Special Feeding Fixture and Motor Drive

direct from the machine drive shaft. Friction clutches provide a safety means in case the machine becomes clogged or it is desirable to operate only one unit. The work is pushed forward between each pair of guides by means of a reciprocating plunger.

An adjustable work plate, mounted directly under the projecting ends of the feeding plungers, is kept close to and level with the grinding disk, so that the work will slide on and off the disk and remain in a level plane at all times. The castings are simply dropped into the guides when the feeding plungers are at the end of the return stroke. A disk truing device is mounted in the center of the machine.

THE GERMAN MACHINERY INDUSTRY

In a report by Trade Commissioner Theodore Pilger of Berlin, Germany, to the Department of Commerce, reference is made to the annual meeting of the German Machinery Manufacturers' Association recently held in Berlin, where the conditions in the German machinery industry were reviewed. This association comprises about 3000 members, constituting about 93 per cent of the total number of machinery and equipment builders in Germany. The members employ about 750,000 people.

At the meeting, objection was raised to the interference of the government in industry, particularly to the dictation of terms governing wages, and the employment or dismissal of workers; the overburdening of industry with constantly increasing expenses for social welfare work was also complained of. It was pointed out that German industry is overdeveloped—there are too many factories manufacturing the same lines of machinery, compared with the sales possibilities. For example, there are between 90 and 100 manufacturers of lathes. Comparison was made with the fact that in the United States there is less than half that number; yet the domestic American market, it was pointed out, is about five times as great as the German, so that in Germany 9 or 10 builders of lathes should be sufficient, or perhaps 15 to 20, considering the relatively larger export trade of Germany. It was further pointed out that there are 60 plants building railway cars, compared with 40 before the war, and that the number of locomotive works in Germany is also greater than in pre-war years, although the German railways are placing practically no orders now, and there is but small chance for exports. There are 53 plants making band saws and 45 making circular saws, and so on throughout the entire field of the machine-building industry.

It was advocated at the meeting that the best way to regulate production in the machine industry was through combinations of firms for the control of production and sales, each firm maintaining its independence as far as manufacturing methods are concerned. There already are about 150 such combinations in the German machine industry. Each combination, on an average, comprises about four individual firms. In one case, an entire trade association has combined its members into a manufacturing and sale combination.

There is also an effort toward specialization, and steps are being taken toward reducing the number of types and models. As an example, it was mentioned that a printing machinery plant that formerly built 26 types and 119 models of printing presses is now producing only one type in four sizes. This plant has thereby increased its capacity by 30 to 40 per cent, and has also increased its sales turnover. Specialization of this kind is especially satisfactory when firms engaged in a specific line come to an agreement as to standardization and simplification.

At the meeting, Professor Schlesinger of the Charlottenburg Engineering Institute, who had just returned from a trip through Russia, stated that the Russian Soviet authorities are not at present interested in developing any export trade in the industrial field, but would prefer to develop an industry in Russia that would make the country self-sustaining, while the exports would be confined to agricultural products rather than to industrial goods.

One of the principal divisions of the German Machinery Manufacturers' Association is the Association of German Machine Tool Builders. This association has about 400 members, and is very active and strongly organized.

* * *

According to the Department of Commerce, the manufacture of machinery in France in 1925 was characterized by a high degree of activity. The exchange situation assured local manufacturers of a good market and discouraged imports, while it stimulated exports. The shipments of industrial machinery from France by weight, in 1925, was nearly double the volume of shipments in 1913. Of foreign-made machinery, machine tools were about the only line that had a fair market in France during the past year.

BOYE & EMMES ARE REBUILDING PLANT

Boye & Emmes Machine Tool Co., Cincinnati, Ohio, whose plant was completely destroyed by fire late in January, informs us that work is progressing rapidly on the clearing away of the debris for the erection of a new building, which will be started immediately, so that operation of the plant may be resumed at the earliest possible moment. Fortunately the patterns of the company were stored in another building and were saved.

* * *

INCREASING THE VALUE OF GOVERNMENT EXPORT STATISTICS

Machinery manufacturers frequently advise the Bureau of Foreign and Domestic Commerce that they derive a great deal of valuable information from the export statistics regularly published, but they complain that in some instances the value of these statistics is destroyed through occasional obvious errors. Careful studies in connection with the problem of providing more dependable statistics reveal that in some instances such errors arise from faulty descriptions in the export declarations filed by shippers at the customhouses at the ports of exportation. Consequently, it is necessary to enlist the cooperation of machinery exporters if the machinery statistics are to be more dependable.

The Government can merely compile the figures given to it by exporters. Therefore, it is incumbent upon shippers to see that the export declarations contain true descriptions of the equipment involved. For this reason, it is suggested that manufacturers themselves fill out these forms in their own offices, since they are familiar with the equipment, instead of delegating the task to export houses or freight forwarders. This important work should not be left to inexperienced office boys or clerks who have an inadequate knowledge of the kinds of machinery described and who have no conception of the importance of the figures. Supervision on the part of the export manager or other person in the manufacturer's organization who is vitally interested in the data, would undoubtedly be beneficial. The information shown in the declarations is regarded as confidential under the customs regulations, and is used only for compiling statistics issued by the Department of Commerce. To assist manufacturers in filling out their export declarations correctly, the Department of Commerce has published a "Glossary of Terms," which may be obtained upon application.

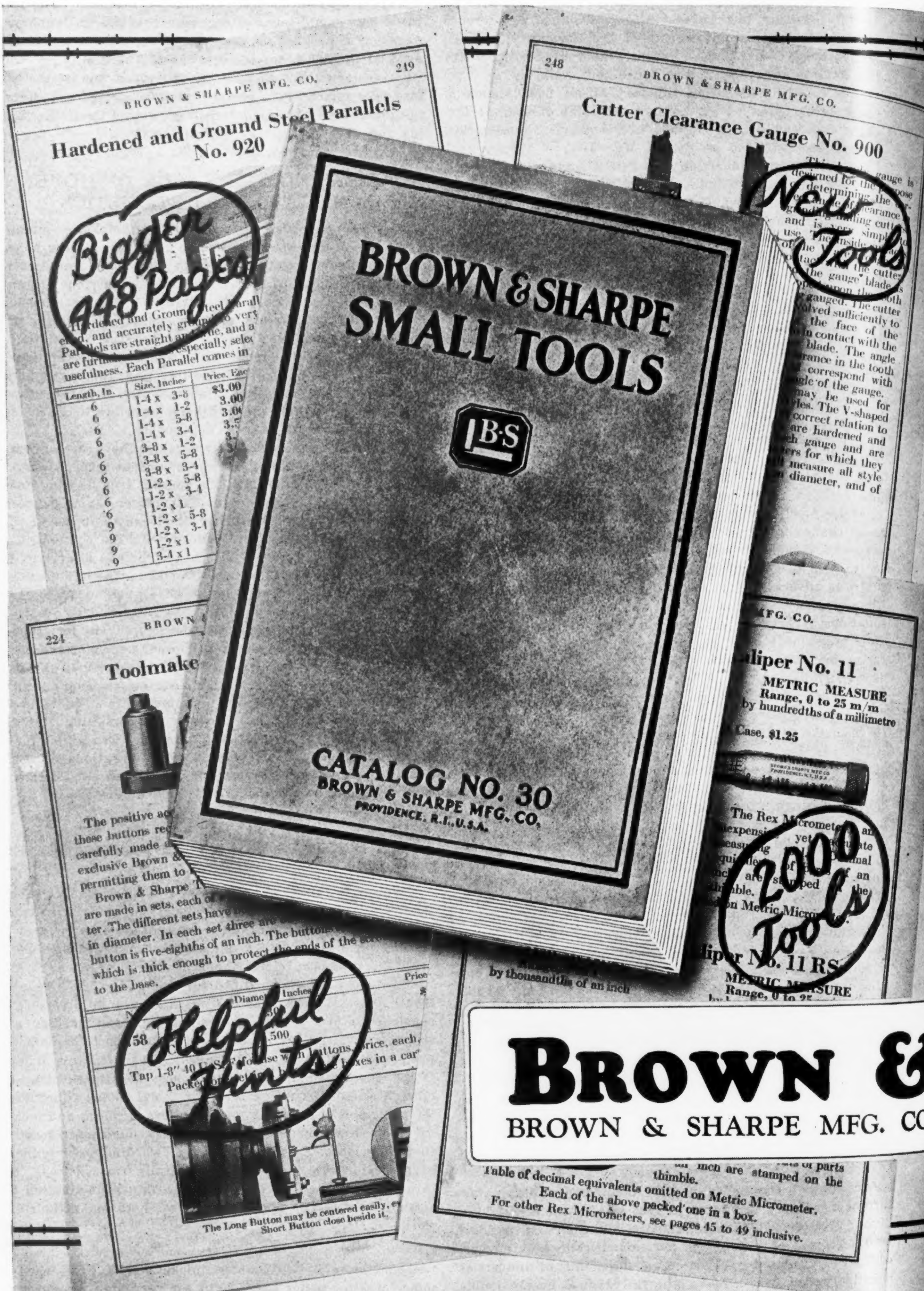
* * *

BOY SCOUTS MAKE A STUDY OF MACHINE SHOP PRACTICE

The Boy Scouts of America award a merit badge to boys who have shown certain proficiency in some art, trade, science or profession. Seventy subjects are now covered by the list for which these merit badges are awarded. One of these merit badges relates to machine shop practice. So far, 7317 boy scouts have qualified for this badge. The requirements are as follows: The boy has to be able to describe the construction of a lathe, planer, shaper, drilling machine, and steam boiler. He is also expected to be able to explain the purpose for which each is intended. He must name at least twelve of the principal hand tools used by a machinist. He must have constructed a wood or metal model illustrating the principles of the lever, gears, pulleys, or block and tackle. In addition, he must have had at least one month's actual shop experience. The purpose of the awarding of these merit badges is not to turn out mechanically trained boys, but rather to help the boys discover their natural inclination for a trade or vocation that they may wish to make their life work.

* * *

According to *The Locomotive*, nickel steel is being used in some cases for boiler shells built for very high pressures in continental Europe. The furnace sheets and the water tubes in such boilers, however, are without exception made from mild steel.



BROWN & SHARPE MFG. CO.
219
Hardened and Ground Steel Parallels No. 920
248
Cutter Clearance Gauge No. 900
224
Bigger 448 Pages
New Tools
BROWN & SHARPE SMALL TOOLS
B·S
CATALOG NO. 30
BROWN & SHARPE MFG. CO.
PROVIDENCE, R.I., U.S.A.
2000 Tools
Helpful Hints
BROWN &
BROWN & SHARPE MFG. CO. PR


New!
The Brown & Sharpe
No. 30
Small Tool Catalog
Everyone who uses Machinists' Tools or Cutters will *need* this up-to-the-minute catalog of Brown & Sharpe quality equipment.
—*more* than a catalog—it is a
Handbook of Small Tools and Cutters
Send for your copy today!
Improved Tools
Shows Tools in Use
1500 Cutters
Tables
Die Makers' Square No. 552
Helical Mill
Gauges No. 585
The 18" Gauges, both English and Metric, are graduated to read on one side only
SHARPE
PROVIDENCE, R. I., U. S. A.

PREVENTING GRINDING WHEEL ACCIDENTS

The following recommendations are from the Safety Code approved by the American Engineering Standards Committee. They refer to precautions that should be taken to prevent accidents in the operation of grinding equipment.

Grinding Machine Requirements — Grinding machines should be sufficiently heavy and rigid to prevent vibration, and should be securely mounted on substantial floors, benches, foundations, or other structures.

Direction of Spindle Thread—Ends of spindles shall be so threaded that the nuts on both ends will tend to tighten as the spindles revolve. Care should be taken in setting up machines to see that the spindles are arranged to revolve in the proper direction, or else the nuts on the ends will loosen. Note: To remove the nuts, they should both be turned in the direction in which the spindle revolves when the wheel is in operation.

Length of Spindle Thread—The length of the spindle and the distance that the thread extends from the end shall be such as to allow the entire length of the nut to bear on the thread so as to exert its full pressure on all thicknesses of wheels which may be used.

Protection Hoods—Hoods should be used on every operation where the nature of the work will permit, and should always be used with wheels that are not provided with protection flanges, chucks, or bands.

Work-rest Adjustment—The work-rest should be kept adjusted close to the wheel, with a maximum distance of 1/8 inch, to prevent the work from being caught between the wheel and rest, and should be securely clamped after each adjustment.

Cup, Cylinder, and Ring Wheels—Cups, cylinders, and sectional ring wheels shall be either protected with hoods, enclosed in protection chucks, or surrounded with protection bands. Not more than one-quarter of the height of such grinding wheels shall protrude beyond the provided protection. Where the thickness of the rim of such wheels is less than 2 inches, the maximum distance that the wheel may protrude beyond the provided protection shall not exceed 1 inch. If the thickness of the rim is 2 inches or more, the wheel may protrude 2 inches beyond the protection, but shall not exceed this amount.

Inspection of Wheels—Immediately upon receipt, all wheels should be closely inspected to make sure that they have not been injured in transit or otherwise. As an added precaution, wheels should be tapped gently with a light implement, such as the handle of a screwdriver. If they sound cracked, they should not be used. Wheels must be dry and free from sawdust when being tested. Before being mounted, all wheels should again be closely inspected to make sure that they have not been injured in transit, storage, or otherwise.

Storage of Wheels—Extreme care should be exercised in the storage of wheels. They should be stored in dry places and should be supported on edge in racks. Straight-sided elastic and rubber-bonded wheels of 1/4 inch or less in thickness should be laid flat on a straight surface to prevent warpage.

Spindle Fit—Grinding wheels should fit freely on the spindles; they should not be forced on, nor should they be too loose.

Surface Condition—All surfaces of wheels, washers, and flanges in contact with each other should be free from foreign material.

Bushing—The soft metal bushing shall not extend beyond the sides of the wheel.

Washers or Blotters—Washers or flange facings of compressible material shall be fitted between the wheel and its flanges. If blotting paper is used, it should not be thicker than 0.025 inch. If rubber or leather is used, it should not be thicker than 1/8 inch. If flanges with babbitt or lead facings are used, the thickness of the babbitt or lead should not exceed 1/8 inch. The diameter of the washers should not be smaller than the diameter of the flanges.

Tightening of Nut—When tightening spindle end nuts, care should be taken to tighten them only enough to hold the wheel firmly; otherwise, the clamping strain is likely to damage the wheel or associated parts.

Responsibility—Competent men should be assigned to the mounting, care, and inspection of grinding wheels and machines.

Inspection after Breakage—Whenever a wheel breaks, a careful inspection shall be made to make sure that the hood has not been damaged, nor the flanges bent or sprung out of true or out of balance. The spindle and nuts shall also be carefully inspected.

Replacing Hood—After mounting a new wheel, care should be taken to see that the hood is properly replaced.

Starting New Wheels—All new wheels shall be run at full operating speed for at least one minute before applying the work, during which time the operator shall stand at one side.

Applying Work—Work should not be forced against a cold wheel, but applied gradually, so as to give the wheel an opportunity to warm and thereby minimize the chance of breakage. This applies to starting work in the morning in cold rooms, and to new wheels which have been stored in a cold place.

Dresser Guards—Wheel dressers, except the diamond type, shall be equipped with guards over the tops of the cutters to protect the operator from flying pieces of broken cutters or wheel particles.

Grinding Room—The space about the machine should be kept light, dry, and as free as possible from obstructions.

Lubrication—Care should be exercised so that the spindle will not become sufficiently heated to damage the wheel.

Flanges—All wheels except those that are mounted in chucks shall always be run with flanges.

Recess in Flanges—Each flange, whether straight or tapered, shall be recessed at the center at least 1/16 inch on the side next to the wheel.

Flange Fit—The inner flange shall be keyed, screwed, shrunk, or pressed on the spindle, and the bearing surface shall run true and at right angles with the spindle. The bore in the outer flange should be not more than 0.002 inch larger than the spindle.

Test for Balance—Wheels should occasionally be tested for balance, and rebalanced if necessary. Wheels worn out of round should be trued by a competent man. Wheels out of balance through wear, which cannot be balanced by truing or dressing, should be removed from the machine.

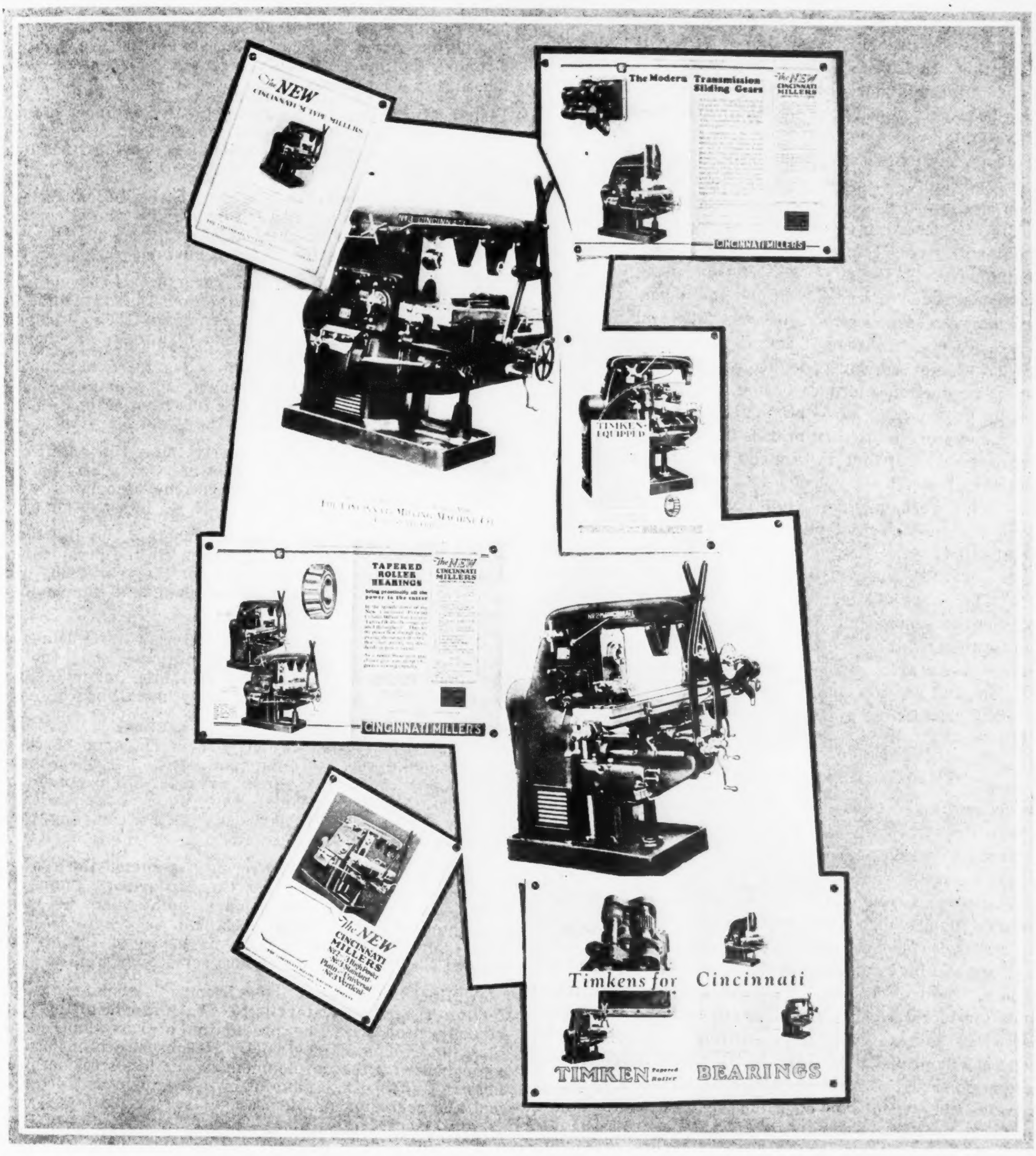
Truing—Truing is best accomplished by the use of a diamond rather than with a wheel dresser, the function of which is dressing only. Truing is not necessarily a sharpening operation, but is what its name implies. Dressing rarely trues a wheel.

Wet Grinding Wheels—Wheels used in wet grinding should not be allowed to stand partly immersed in the water. The water-soaked portion may throw the wheel dangerously out of balance. All wet tool grinders that are not so designed as to provide a constant supply of fresh water should be thoroughly drained at the end of each day's work, and a fresh supply provided just before starting.

Side Grinding—Grinding on the flat sides of straight wheels is often hazardous, and should not be allowed on operations where the sides of the wheel are appreciably worn thereby or where any considerable or sudden pressure is brought to bear against the sides.

* * *

The imports of machinery into Italy during the first nine months of 1925 exceeded the total for the entire year of 1924, both in tonnage and value. The machine tool imports amounted to 7500 metric tons, and of these the United States supplied about 15 per cent, Germany supplying about 65 per cent. The increase in the imports of machine tools from the United States was very marked. During the corresponding nine-month period in 1923, only 36 tons were imported, and in 1924, 164 tons; the imports in 1925, were nearly six times as great as in the preceding year.



ANOTHER EXCLUSIVE FEATURE

When you can get 15% greater cutting capacity from your Timken Roller Bearing equipped Cincinnati Milling Machines it is no wonder that each day finds more plants and more operators asking for, and installing these machines. Careful investigation will prove to you that this and all other productive features on Cincinnati Millers will help to prolong prosperity for your plant in 1926. It is not necessary to "Hamper Your Skilled Men with Obsolete Equipment" if you install Cincinnati Millers. We will gladly send you interesting booklets describing our new Pyramid Column Machines. Drop us a postal.

THE CINCINNATI MILLING MACHINE CO.

CINCINNATI·OHIO·U·S·A·

CINCINNATI MILLERS

TRADE STATISTICS ARE NEEDED

The need of more and better data in modern business management, to the lack of which many of the "ups and downs" of business are attributed, is emphasized in a bulletin just issued by the Department of Manufacture of the Chamber of Commerce of the United States. Since the recent court decisions on the subject, it is stated, many trade associations have gone into this work concerning which much information has been gathered by the National Chamber and will be made available upon request.

"Trade associations," says the bulletin, "can render to their members no more valuable service than perfecting their methods of gathering, compiling, and reporting to them, and making available to the Government and public, current figures that will give a composite picture of what is going on in the industry.

"The peaks and valleys of supply and demand in commodity markets—sometimes called the 'ups and downs' in business—are due in no small degree to lack of dependable figures to guide or influence judgment in the individual regulation of production and distribution. Individual errors in estimating or guessing as to production, shipments, stocks, etc., in the aggregate often culminate in over-production and the stagnation of distribution in many lines, to the great loss and detriment of all concerned.

"Why don't we have these vital figures? The answer is, we do, in a number of outstanding and successful lines which appreciate their value, but in the remainder, the chief reason is the unwillingness of business to give up its figures, because it has not fully realized the value and use of statistics in business management. Secondly, and also most important, is the fact that too many forms for presenting these facts have been arranged to gratify the ambition of the statistician, and are too complicated to convey the information readily assimilable by the average business man.

* * *

THE RAILROAD SITUATION

The net earnings of the railroads of the United States for 1925 were the largest in history, but since great additional investments have been made in the properties during recent years, the actual percentage rate of return was less than in 1916. The present return is 5 1/2 per cent on the Interstate Commerce Commission's tentative valuation, or 4.83 per cent on the railroads' book values. Traffic continues to be satisfactory, car loadings running ahead of the same period for past years. Several classes of railroad workers have made demands for increased pay, but it is not believed that these increases can be granted in their entirety at present. The differences will probably be adjusted in a peaceful manner, as there is no threat or tendency toward a strike.

The railroads continue to be in good condition to handle all the traffic coming their way. Approximately 300,000 surplus freight cars in good repair are immediately available for service. During 1925 nearly 130,000 freight cars were placed in service, and 40,000 additional cars were on order on the first of the year. Also, 1733 locomotives were placed in service, and 471 were on order on the first of the year.

* * *

According to a bulletin issued by the Department of Commerce, Washington, D. C., $50,000,000 is the cost to the industries of the United States each year because of the prevailing disregard of simple rules in wrapping and packing merchandise for domestic shipping. This reference is specifically to paper-wrapped packages. This huge loss must necessarily be absorbed by increased rates for transportation and insurance. A report has been issued by the Department of Commerce covering the subject; this report contains instructions for wrapping packages with paper for parcel post and express shipment. Copies may be had upon application to the Superintendent of Documents, Government Printing Office, Washington, D. C., or from any district office of the Bureau of Foreign and Domestic Commerce. The price is 5 cents. Lots of 1000 are sold for $20.

PERSONALS

ROBERT J. BELER has recently joined the Pittsburg sales office of Foote Bros. Gear & Machine Co., 215 N. Curtis St., Chicago, Ill., as assistant to W. G. Kerr, district representative.

S. T. JOHNSTON, vice-president and general manager of the S. Obermayer Co., Chicago, Ill., was elected president of the Foundry Equipment Manufacturers' Association, at its recent meeting in Cleveland.

M. J. MILLER has been appointed sales engineer of the Diamond Power Specialty Corporation, Detroit, Mich., in charge of the Detroit district. Mr. Miller has previously had charge of the Philadelphia district.

J. H. HORIGAN, who has been with the Union Twist Drill Co., Athol, Mass., since it was formed, and who at the present time occupies the position of chief engineer, has been elected secretary and a director of the company.

GEORGE T. TRUNDLE, JR., ENGINEERING Co., Cleveland, Ohio, at the last annual meeting of the board of directors, elected A. M. Corcoran secretary of the company. The other officers of the company remain the same as before.

A. R. PINNEY has joined the sales force of the Bonney Forge & Tool Works, Allentown, Pa., manufacturers of chrome-vanadium wrenches. He has been assigned territory including Pennsylvania, New Jersey, and Maryland.

ALBERT V. BROUILLETTE, formerly industrial engineer with the Westinghouse Electric & Mfg. Co., East Springfield Works, Springfield, Mass., has become associated with the Savage Arms Corporation, Utica, N. Y., in a similar capacity.

THOMAS J. LITLE, JR., chief engineer of the Lincoln Division of the Ford Motor Co., has been elected president of the Society of Automotive Engineers for the year 1926. He succeeds Harry L. Horning who was president during the past year.

E. A. C. BAUM has been appointed assistant western representative for steel sales of Henry Disston & Sons, Inc., Philadelphia, Pa., with headquarters at 111 N. Jefferson St., Chicago, Ill. Mr. Baum was formerly metallurgical engineer with the Illinois Tool Co.

GEORGE T. AITKEN, formerly sales manager of the Vonnegut Machinery Co., Indianapolis, Ind., has been appointed manager of the machine tool motor sales department of the electrical division of Fairbanks, Morse & Co., with headquarters at the electrical works of the company, 2060 N. Western Ave., Indianapolis, Ind.

HERMAN STEINKRAUS has recently assumed the representation of the Bridgeport Brass Co., Bridgeport, Conn., in the Cleveland territory. For the last eight years he has been connected with the Osborn Mfg. Co. as general sales manager. Mr. Steinkraus will have charge of the Bridgeport Brass Co.'s Cleveland warehouse service, as well as sales.

T. HOLLAND NELSON has become associated with the Ludlum Steel Co., Watervliet, N. Y., in a consulting capacity in connection with the production of rust- and corrosion-resisting iron and steel. Mr. Nelson has been intimately connected with the development of rustless steel both in this country and in England, and is well known as a lecturer on rust and corrosion problems.

H. H. SNELL, formerly manager of the gear department of the Charles Bond Co., Philadelphia, Pa., has recently been appointed district representative for the Foote Bros. Gear & Machine Co., 215 N. Curtis St., Chicago, Ill. Mr. Snell's territory covers eastern Pennsylvania, Delaware, Maryland, and the southern half of New Jersey. The Charles Bond Co., formerly representative for the Foote Bros. Gear & Machine Co., will continue to handle the IXL line as jobbers.

A. H. TISCHER has recently joined the engineering force of the Foote Bros. Gear & Machine Co., 232-242 N. Curtis St., Chicago, Ill., as designing engineer. Mr. Tischer was connected with the company during 1916 and 1917, but left to join the Air Service during the war. After the war, he became connected with the P. T. Wheel Co. of Dayton, Ohio, as designing engineer, and later with the Steinmetz Electric Motor Car Corporation, as engineer in the tractor division.

JAMES ASTON, for the last five years metallurgical engineer in charge of research with the A. M. Byers Co., Pittsburg, Pa., has been appointed professor of mining and metallurgy and head of the department of mining and metallurgical engineering of the Carnegie Institute of Technology, Pittsburg, Pa. This appointment fills the vacancy caused by the death of Fred Crabtree last February. Professor F. F. McINTOSH, who has been in charge of the department as acting head since Professor Crabtree's death, has resigned to take a position with the Crucible Steel Co.

TRADE NOTES

Wagner Electric Corporation has moved its Omaha office to 2566 Leavenworth St.

Geometric Tool Co., New Haven, Conn., has appointed the Sidney B. Roby Co., 208 South Ave., and 8 Capron St., Rochester, N. Y., agent for the company in Monroe County, N. Y.

Strom Division of the Marlin-Rockwell Corporation has moved its Philadelphia office to 1211 Franklin Trust Bldg., 15th and Chestnut Sts. A. W. Wiese will continue as manager in that territory.

Griscom-Russell Co., manufacturer of heaters, evaporators, filters, etc., has removed its general offices from 90 West St. to the new Murray Hill Bldg. at 40th St.—285 Madison Ave., New York City.

De Luxe Metal Furniture Co., Warren, Pa., has been organized to manufacture metal shelving and office furniture. H. P. Stone is president of the new company, and H. J. Onions, head of the production department.

Reading Chain & Block Corporation, Reading, Pa., manufacturer of chain hoists, electric hoists, and other material handling equipment, has recently opened an office in Pittsburg, Pa., at 327 First Ave., in charge of Lloyd W. Lutz.

Lustro Coated Sheets Co., Pittsburg, Pa., has placed a contract with the Austin Co., Cleveland, Ohio, for the construction of a new plant, which will increase the company's facilities for manufacturing steel and tin sheets 50 per cent.

National Twist Drill & Tool Co., Detroit, Mich., announces the election of the following officers: Chairman of the board, William H. McGregor; president, Howard L. McGregor; and vice-president and manager of sales, C. Earle Smith.

Acme Electric Welder Co., Bourse Bldg., Philadelphia, Pa., has appointed A. V. B. Cutler, welding engineer, as representative for the company's product in the Middle West. Mr. Cutler's headquarters will be 817 W. Washington Blvd., Chicago, Ill.

Crilly Mercury Anti-Friction Metal Corporation, 70 Clarke Ave., Jersey City, N. J., announces that in the future it will handle all sales direct. Sales of the company's mercury bearing metal were formerly handled by the Metal Sales Co. of Jersey City.

Kearney & Trecker Corporation, Milwaukee, Wis., has opened a new branch office in Indianapolis, Ind., with headquarters at Room 614 Traction Bldg. Robert W. Ott, formerly connected with the Chicago office, will be in charge of the new Indianapolis territory.

Northern Engineering Works, Detroit, Mich., manufacturers of traveling cranes, electric hoists, and foundry equipment, at the annual meeting of stockholders elected the following officers: President and treasurer, Henry W. Standart; vice-president, Harry C. Bulkley; and secretary, Louis H. Olfs.

Ex-Cell-O Tool & Mfg. Co., 1473 E. Grand Boulevard, Detroit, Mich., has appointed Williams, Cole & Wolff of Milwaukee, Wis., representative of the company for the state of Wisconsin, and the Hausman-Harwick Machine Tool Co., of Birmingham, Ala., sales representative for the state of Alabama.

Dreis & Krump Mfg. Co., 74th St. and Loomis Blvd., Chicago, Ill., announces that it has sold the "Atlas Carryall" overhead conveying system to the Chicago Electric Co., 740 W. Van Buren St., Chicago, Ill. In addition to the hand-operated system now on the market, an electrically operated track will be offered.

Dreses Machine Tool Co., Cincinnati, Ohio, has contracted with the Austin Co., of Cleveland, Ohio, for the construction of a new plant. The new building will be of one-story design, 90 feet wide by 300 feet long, with monitor roof. Two five-ton cranes will be installed in the center aisle, and one three-ton crane in the side aisle.

Monitor Controller Co., Baltimore, Md., manufacturer of automatic controllers for all kinds of motor-driven apparatus, has appointed the Electric Material Co. of San Francisco and Los Angeles, Calif., Pacific Coast representative of the company. It is proposed eventually to have some stock of standard equipment carried in San Francisco.

Cleveland Graphite Bronze Co., manufacturer of bronze bushings, formerly located at 2906 Chester Ave., Cleveland, Ohio, has recently moved into the company's new building at 880 E. 72nd St., of the same city. The new plant is fully equipped with machinery of the latest type; 35,000 square feet of floor area provides ample space for the increased production of the concern.

Lapham-Hickey Co., 1625 W. Pershing Road, Chicago, Ill., has been organized by men formerly with the Fitzsimons Steel & Iron Co. and Edgar T. Ward's Sons Co. to handle the same lines of steel formerly furnished by those companies. A complete stock of rounds, flats, squares, and hexagons in the various S. A. E. analysis will be carried at the Chicago office, as well as a complete stock of cold-rolled strip steel and cold-rolled flat wire.

Husky Wrench Co., 928 Sixteenth Ave., Milwaukee, Wis., manufacturer of automotive and industrial wrenches, has added the following tools to their line of standard socket wrenches: A complete line of square sockets, ranging from 3/8 inch to 1 inch square; four additional large hexagon sockets, from 1 13/16 to 2 3/8 inches; a heavy-duty ratchet, 20 inches long; and two sizes of speeders with upset forged and milled ends and swivel grips, ratchet, brace, and extra long combination tee.

Defiance Machine Works, Defiance, Ohio, announce that the Charles A. Strelinger Co. of Detroit, Mich., has taken over the exclusive sale, in the Lower Peninsula of the state of Michigan, of the Defiance Machine Works' line of standard metal-working machinery, consisting of horizontal boring mills, heavy-service drilling machines, rail drilling machines, No. 10 multiple adjustable straight-line drilling machines, and valve grinding machines.

Loshbough-Beck Press Co., Elkhart, Ind., has recently been organized to manufacture open-back inclinable presses. The officers of the company are J. E. Loshbough, president and general manager; L. E. Loshbough, vice-president; and H. M. Beck, secretary and treasurer. J. E. Loshbough was formerly president and partner of the Loshbough-Jordan Tool & Machine Co., of Elkhart, Ind., but has sold his interest in that company. He has had fifteen years experience in the designing and building of presses.

Erie Foundry Co., Erie, Pa., manufacturer of hammers, trimming presses, and other forge shop equipment, is opening several district sales offices at the following locations: 1120 Myrtle Ave., Plainfield, N. J., in charge of Howard Terhune; 549 Washington Blvd., Chicago, Ill., in charge of L. F. Carlton; 408 Donovan Bldg., Woodward Ave., at Duffield St., Detroit, Mich., in charge of R. B. McDonald. The company is also increasing its manufacturing facilities, adding both new buildings and equipment, to take care of its increasing business.

R. Charles Brower has been promoted to the position of assistant to H. J. Porter, vice-president in charge of sales of the Timken Roller Bearing Co., Canton, Ohio. Mr. Brower first became associated with the company in 1916 as district manager of the Bearings Service Co., with offices in Detroit. Upon the dissolution of this company in 1922, the Timken Roller Bearing Service & Sales Co. was organized, with headquarters at Canton. Mr. Brower then went to Canton as assistant general manager, which position he has held until his present promotion.

Crescent Tool Co., Jamestown, N. Y., has purchased the entire capital stock of the Smith & Hemenway Co., Inc., Irvington, N. J. L. P. Smith, president of the Smith & Hemenway Co., is retiring because of ill health. The executive offices of the company only will be moved to Jamestown. The glaziers' tool business of the company has been transferred to Landon P. Smith, Inc., 100 Coit St., Irvington, N. J., but the remainder of the "Red Devil" tool line will be manufactured and sold by Smith & Hemenway, Inc., 130 Coit St., Irvington, N. J., the same as heretofore.

National Grinding Co., 146 E. Woodbridge St., Detroit, Mich., and the Tool Salvage Co., 407 E. Fort St., Detroit, have merged into one company under the name of the National Tool Salvage Co., to conduct a general business reclaiming milling cutters, drills, and reamers. For the present, the shops of both companies will continue to be operated. The officers of the new company are Harry M. Lewis, president; Hiram Ash, vice-president; Orville L. Hatt, treasurer; Arthur J. Moquin, secretary; and Frank E. Price, chairman of the board of directors.

Sheet Aluminum Corporation, Jackson, Mich., has commenced operation of its sheet aluminum rolling mill, with a view to producing a full line of aluminum sheets. The Sheet Aluminum Corporation succeeds the Northern Mfg. Co., which was organized for plant construction purposes. The general sales offices of the corporation are located in the Ford Building, Detroit, Mich. W. J. Moore is vice-president in charge of sales. Mr. Moore is also president of the Allied Metal Products Corporation of Detroit, manufacturer of extruded aluminum moldings, bars, and shapes.

Buhling & Klingelnberg, Anhaltstrasse 5, Berlin, S.W. 11, Germany, is a new firm that has been organized for the sale of high-production machinery and equipment. Correspondence with American manufacturers of machine tools is invited with a view to exclusive agency arrangements. The new firm works in close cooperation with Messrs. W. Ferd. Klingelnberg Söhne, at Remscheid, Germany, makers of small tools, having ten branch sales offices throughout Germany, together with selling arrangements in Holland, Belgium, France, Spain, Switzerland, and Czecho-Slovakia. At the central office of the new company, a reference department is being organized covering American machine tools and accessories, for which catalogues are solicited.

4 Reasons

Why WETMORE Reamers Cut Production Costs

Wetmore Expanding Six-blade Standard Finishing Reamer with arbor integral.

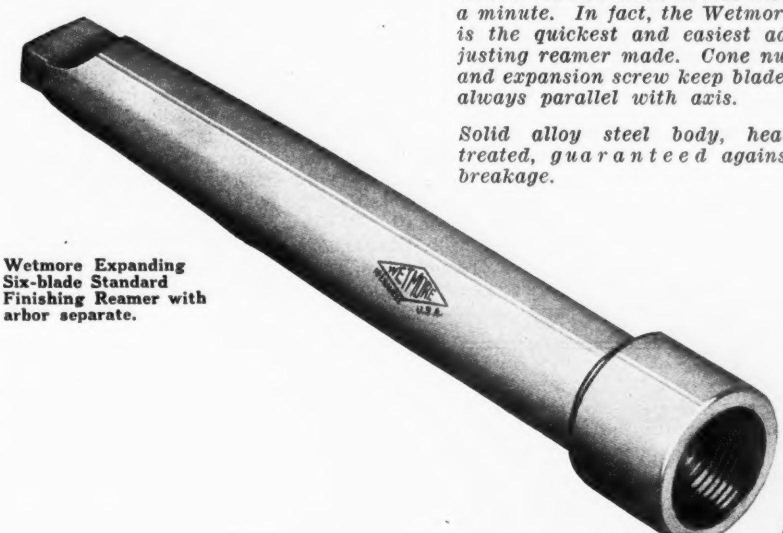
Production men in many of the largest plants are specifying Wetmore Expanding Reamers because Wetmores have proved—on actual tests—that they do *better, more accurate work at less cost.* Here are four features that make Wetmore the reamer preferred by men who know what it can do:

Adjustments to the thousandth of an inch can be made in less than a minute. In fact, the Wetmore is the quickest and easiest adjusting reamer made. Cone nut and expansion screw keep blades always parallel with axis.

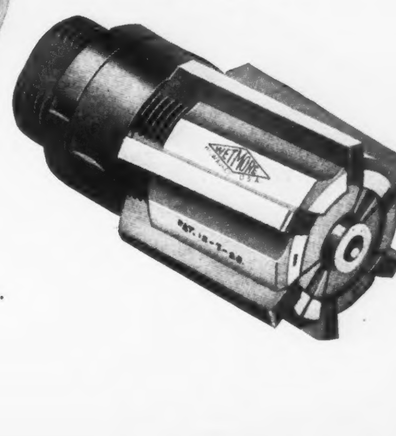
Solid alloy steel body, heat-treated, guaranteed against breakage.

Left Hand Angle Cutting Blades that prevent digging in, chattering and scoring while backing out. Shearing effect of blades increases life of cutting edge.

No grinding arbor required for regrinding. Wetmore Reamers can be reground on their original centers.



Wetmore Expanding Six-blade Standard Finishing Reamer with arbor separate.



Wetmore Blades are carried in stock for all types of Wetmore Reamers. Best high-speed steel, ground to thickness, length, and on seat. In ordering, give type and size of reamer and whether reamer is to be used on steel, cast iron, or bronze, etc.

Give a Wetmore Reamer a trial on a good stiff job and compare its work with that of reamers you've been using. You be the judge—and we'll rest our case with you.

Write for catalog of full line of standard, heavy-duty, shell, small machine and cylinder reamers, arbors, replacement blades. Sent FREE—postpaid.

WETMORE REAMER CO.
MILWAUKEE, WISCONSIN

WETMORE EXPANDING REAMERS
"THE BETTER REAMER"

OBITUARIES

A. PARKER NEVIN, since 1912 secretary and director of the Watson-Stillman Co., New York City, died of pneumonia February 2, after a few days' illness. Mr. Nevin was born at Ridley Park, Pa., on April 6, 1875. He was a Princeton graduate, of the class of 1895, and for many years was counsel of the National Association of Manufacturers.

CARTER MILLER, advertising manager of the Timken Roller Bearing Co., Canton, Ohio, died January 11 after a brief illness from pleura-pneumonia. Mr. Miller was born in Bay City, Mich., and graduated from Kenyon College at Gambier, Ohio, in 1919. He then became associated with the Timken Roller Bearing Co., and was promoted rapidly to various positions, both in the field and in the home office. Some time ago he was given charge of the advertising department, which position he held until the time of his death. His ability in handling publicity problems was widely recognized.

ARTHUR R. BUSH, manager of the industrial department of the General Electric Co., Schenectady, N. Y., died at his home in Schenectady on January 24. Mr. Bush was born in Fall River, Mass., in 1861. He graduated from Annapolis in 1882, and served two years in the United States Navy. In 1884, he entered the employ of the Edison Co., following which he was connected with the New England Wiring & Construction Co. In 1892, he was made district engineer of the Edison General Electric Co. in the New England district, resigning this position in 1904 to accept the vice-presidency of the Union Bag & Paper Co. He remained with this concern until 1906, when he returned to the General Electric Co., becoming manager of the power and mining department, and later manager of the industrial department.

I. H. THEDIECK, president of the Sidney Machine Tool Co. and the Monarch Machine Tool Co., both of Sidney, Ohio, died at Mt. Carmel Hospital in Columbus, Ohio, January 20, at the age of seventy-one years. Mr. Thedieck was born in Althausen, Germany, January 30, 1855, where his father was a merchant. He was not quite seventeen years old when he arrived in America, and he was less than twenty when he engaged in the retail drygoods business for himself. While he remained in this line of business during his entire life, being president of the Thedieck Department Store Co., he also became interested in the machine tool business, being president of the two machine tool companies mentioned and also a director of the Whipp Machine Tool Co. He was a director of the First National Exchange Bank, Sidney, Ohio, the Anderson Body Co., and the Sidney Telephone Co. At one time he also served as president of the Sidney Commercial Club. He is survived by his widow and by his son, Frank P. Thedieck, upon whom lately devolved, owing to his father's illness, the management of his affairs.

JOHN JACOB BAUSCH

John Jacob Bausch, founder and president of the Bausch & Lomb Optical Co., Rochester, N. Y., died February 14 at his home in Rochester at the age of ninety-five. Until about a year ago he was active in the business he founded, making occasional visits to the plant. The story of Mr. Bausch's life is the story of the triumph of a poor immigrant boy over difficulties that met him with discouraging frequency during his early days in America. He was born in 1830 in Germany, and at an early age worked for his brother, who made and dealt in optical instruments. He served an apprenticeship in this business both in Germany and Switzerland, and at the age of nineteen arrived in the United States.

He first came to Buffalo where, after many hardships, he learned the wood carving trade in a furniture factory. After having saved a small sum of money, he went to Rochester, where he entered the optical business, renting the window of a German watchmaker for a dollar a week. The venture failed within a month, and he was forced to return to the wood carving business. Unfortunately, he met with an accident that resulted in the loss of two fingers, which incapacitated him for further work in this trade, and he began, in a most humble way, the optical business that during his lifetime has developed into the present Bausch & Lomb Optical Co.

It was in 1853 that he opened the first business of his own for the sale of eye-glass lenses, and shortly afterward he proceeded to grind his own lenses, borrowing $60 from Henry Lomb, and giving as security the promise that Mr. Lomb would be made a partner if the business ever warranted such a move. By gradual stages the business increased. Larger quarters were rented in 1864; the factory space was again increased in 1868, and the first building on the present site of the plant was built in 1874. Thus the business has gradually developed from one making mainly eye-glass lenses and frames to one that produces practically every type of optical instrument made. During the World War, the Bausch & Lomb Optical Co. developed methods for producing optical glass, a product that formerly had been imported from Germany, and during the war period, the plant was engaged almost entirely in the making of the various types of optical instruments required by the Government. At the peak of war work, 6000 people were employed in the plant—practically double the normal number of 3000.

Mr. Bausch was active in the business and community life of Rochester. He was at one time president of the Mechanics Savings Bank and of the Rochester General Hospital, and was honorary president of both of these institutions at the time of his death.

Mr. Bausch is survived by his wife; two daughters, Mrs. Carl F. Lomb and Mrs. William A. E. Drescher; two sons, Edward and William Bausch; and also by four grandchildren and ten great-grandchildren.

COMING EVENTS

MARCH 2-5—Exhibit of road-building, road maintaining, and contractors' machinery, and road materials, to be held at the Coliseum, Wichita, Kan. F. G. Wieland, general manager, Exposition Building, corner Water and William Sts., Wichita, Kan.

MARCH 3-5—Annual convention of the American Management Association at the Hotel Astor, New York City. Secretary's address, 20 Vesey St., New York City.

MARCH 17-23—First national heating and ventilating exposition, including plumbing, refrigeration and illumination, at the New Madison Square Garden, Eighth Ave. and 49th St., New York City. Executive offices of the exposition, Suite 334, Hotel McAlpin, New York.

APRIL 6-8—Third annual convention and exposition of the American Oil Burner Association in Detroit, Mich. Headquarters, Book-Cadillac Hotel. Executive secretary, Leod D. Becker, 350 Madison Ave., New York City.

APRIL 15-16—Twenty-eighth convention of the National Metal Trades Association, to be held at the Hotel Astor, New York City. J. E. Nyhan, National Secretary, Peoples Gas Bldg., Chicago, Ill.

APRIL 28-30—Thirteenth annual convention of the National Foreign Trade Council in Charleston, S. C. Secretary, O. K. Davis, India House, Hanover Square, New York City.

MAY 3-6—Regional meeting of the American Society of Mechanical Engineers at Providence, R. I. Luther D. Burlingame, Brown & Sharpe Mfg. Co., Providence, R. I., chairman of the local committee. Calvin W. Rice, 29 W. 39th St., New York City, secretary of the society.

MAY 13-15—Annual meeting of the American Gear Manufacturers' Association in Detroit, Mich. Headquarters, Book-Cadillac Hotel; secretary, T. W. Owen, 2443 Prospect St., Cleveland, Ohio.

JUNE 1-4—Semi-annual meeting of the Society of Automotive Engineers at French Lick Springs, Ind. Coker F. Clarkson, 29 W. 39th St., New York City, secretary.

JUNE 16-18—Thirteenth national convention of the Society of Industrial Engineers to be held at the Bellevue-Stratford Hotel, Philadelphia, Pa. The keynote of the convention will be "Practical Methods for Eliminating Waste." George C. Dent, executive secretary, 608 S. Dearborn St., Chicago, Ill.

JUNE 19-26—Convention and exhibit of the Mechanical Division, American Railway Association, Young Million Dollar Pier, Atlantic City, N. J. Secretary of the Mechanical Division: V. R. Hawthorne, 431 S. Dearborn St., Chicago, Ill. Secretary-treasurer of the exhibit: J. D. Conway, 1841 Oliver Bldg., Pittsburg, Pa.

JUNE 21-25—Twenty-ninth annual meeting of the American Society for Testing Materials at the Chalfonte-Haddon Hall Hotel, Atlantic City, N. J. Secretary's address, 1315 Spruce St., Philadelphia, Pa.

JUNE 28-JULY 1—Spring meeting of the American Society of Mechanical Engineers at San Francisco, Cal. Warren H. McBryde, California & Hawaiian Sugar Refining Corporation, 215 Market St., San Francisco, Cal., chairman of the local committee. Calvin W. Rice, 29 W. 39th St., New York City, secretary of the society.

SEPTEMBER 20-24—Eighth annual convention and exposition of the American Society for Steel Treating to be held at the Municipal Pier, Chicago, Ill. W. H. Eisenman, secretary, 4600 Prospect Ave., Cleveland, Ohio.

SEPTEMBER 27-OCTOBER 2—Annual convention of the American Foundrymen's Association and second international foundry congress in Detroit, Mich. In conjunction with these conventions there will be held an international exposition of foundry and machine shop equipment and supplies. C. E. Hoyt, secretary-treasurer, 140 S. Dearborn St., Chicago, Ill.

OCTOBER 2-10—Southern exposition to be held in the new Madison Square Garden, Eighth Ave. and 49th St., New York City. W. G. Sirrine, president of the exposition, New Madison Square Garden, New York City.

NEW BOOKS AND PAMPHLETS

STATISTICAL ABSTRACT OF THE UNITED STATES (1924). 824 pages, 6 by 9 inches. Published by the Bureau of Foreign and Domestic Commerce of the United States Department of Commerce. Sold by the Superintendent of Documents, Government Printing Office, Washington, D. C. Price (paper covers) $1.

THE BUREAU OF STANDARDS. By Gustavus A. Weber. 299 pages, 6 by 9 inches. Published by the Johns Hopkins Press, Baltimore, Md. Price, $2.

This book is one of a series of Service Monographs of the United States Government which has been prepared by the Institute for Government Research, Washington, D. C.—an association of citizens for cooperating with public officials in the scientific study of government with a view to promoting efficiency and economy in its operations and advancing the science of administration.

MECHANICAL WORLD ELECTRICAL POCKETBOOK (1926). 400 pages, 4 by 6 inches. Published by Emmott & Co., Ltd., 65 King St., Manchester, England. Price, 1/6 net.

The 1926 edition of this little electrical pocketbook, which is in the nineteenth year of its publication, contains a number of new features. New sections have been included on jointing conductors; magnetic chucks and clutches; industrial application of electro-chemistry; industrial electric heating; cutting by the electric arc; and depreciation. The section on electric hoists has been replaced by a more extensive one on electric lifts, cranes, etc.

A TREATISE ON DIMENSIONING. By John F. Faber. 64 pages, 6¾ by 10¼ inches. Published by the Bruce Publishing Co., 354 Milwaukee St., Milwaukee, Wis. Price, 68 cents.

Clear and correct dimensioning of mechanical drawings is of the utmost importance, for misunderstandings due to poorly dimensioned drawings often lead to costly errors and loss of valuable time in the shop. A book devoted to dimensioning should, therefore, be of interest to students of drawing. This book has been planned with the intention of teaching the proper dimensioning of drawings in the shortest possible time. The manual does not attempt to cover all phases of drawing, but deals only with the elements of simple machine and woodworking drawings, not including floor plans or elevations, such as are used in architectural drawing. The exercises are intended to develop in the student a fair degree of skill in dimensioning through the understanding and application of a few generally accepted rules. The plates are the result of lessons successfully used for a number of years by the author.

NEW CATALOGUES AND CIRCULARS

FILES. Nicholson File Co., Providence, R. I. Circular showing the use of Nicholson files in the navy.

SHAPERS. R. A. Kelly Co., Xenia, Ohio. Catalogue containing illustrations and specifications of Kelly crank shapers.

AMMONIA COMPRESSORS. American Engineering Co., Philadelphia, Pa. Catalogue descriptive of Juruick ammonia compressors.

SAFETY WASHER FOR GRINDING WHEELS. George W. Perks Co., Inc., Akron, Ohio. Leaflet descriptive of the Perks safety washer for abrasive wheels.

TOOL STEEL. Columbia Tool Steel Co., Chicago Heights, Ill. Tool Steel Handbook, containing a complete treatise on the use and handling of Columbia tool steels.

AIR COMPRESSORS. General Electric Co., Schenectady, N. Y. Bulletin GEA-233, descriptive of General Electric centrifugal air compressors of the single-stage type.

HEATERS. Modine Mfg. Co., Racine, Wis. Bulletin A, outlining the features of the Modine unit heater for steam or hot water heating systems, and illustrating typical installations.

BALL BEARINGS. New Departure Mfg. Co., Bristol, Conn. Revised sheet No. 60FE for loose-leaf binder, illustrating and describing the application of ball bearings in conveyor rolls.

MAGNETIC CHUCKS. O. S. Walker Co., Inc., Worcester, Mass. Circular T1, illustrating and describing magnetic chucks for use on heavy-duty face and surface grinders, milling machines, and planers.

ELECTRIC CONTROLLING APPARATUS. Allen-Bradley Co., Milwaukee, Wis. Bulletin 330, descriptive of the Allen-Bradley type F-2250 crane, hoist, and mill controller for general crane and mill service.

MILLING CUTTERS AND COLLETS. Reed-Prentice Co., Worcester, Mass. Circular giving dimensions and prices of milling cutters and collets for use on Becker Nos. 2A and 3 vertical milling machines.

BALL BEARINGS. Bearings Co. of America, Lancaster, Pa. Loose-leaf pamphlet containing dimensions, load capacities, and prices for thrust ball bearings, angular contact ball bearings, and ball retainers.

GRINDING AND POLISHING MACHINERY. Hemming Bros. Co., New Haven, Conn. Catalogue containing specifications and illustrations covering this company's line of automatic cutlery grinding and polishing machinery.

FLEXIBLE FIXTURE HANGERS. Crouse-Hinds Co., Syracuse, N. Y. Circular illustrating and describing the Crouse-Hinds line of flexible hangers for electric fixtures. Bulletin 2084, giving dimensions and prices of flexible fixture hangers.

NUTS, BOLTS AND BARS. Milton Mfg. Co., Milton, Pa. Catalogue 29, containing dimensions and price lists for the line of nuts, bolts, and bars made by this company. The catalogue is provided with a thumb-index for ready reference.

WRENCHES. Bonney Forge & Tool Works, Allentown, Pa., are distributing miniature copies of their catalogue No. 26. The pamphlets are a convenient size to carry in the vest pocket, and contain both dimensions and prices of the entire line.

AIR ECONOMIZERS. B. F. Sturtevant Co., Boston, Mass. Circular entitled "New Developments in Economizers," describing an air economizer with removable, reversible chambers, and a steel-tube economizer that is lead-coated to resist corrosion.

ELECTRIC DRIVES. Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. Circular 7381, entitled "Electrical Drives for Power Plant Auxiliaries," giving information on the selection of auxiliary drives that will supply continuity of service.

BLOWERS, EXHAUSTERS, AND AIR WASHERS. American Blower Co., Detroit, Mich. Bulletin 1608, illustrating and describing type P pressure blowers and exhausters. Bulletin 1923, describing the application of "Sirocco" air washers.

CUTTING AND WELDING TORCHES. Alexander Milburn Co., 1416 W. Baltimore St., Baltimore, Md. Catalogue illustrating and describing the Milburn line of cutting and welding torches, as well as cutting and welding tips for use with these torches.

ANTI-FRICTION BEARING METAL. Crilly Mercury Anti-Friction Metal Corporation, Jersey City, N. J. Circular entitled, "Something New in Bearing Metals," telling what Crilly mercury anti-friction bearing metal is, and the advantages claimed for it.

COLD-FINISHED STEEL BARS. Moltrup Steel Products Co., Beaver Falls, Pa. Pamphlet outlining standard practices relating to the production of cold-finished steel bars. The pamphlet gives standard manufacturing tolerances, and tables of weights of round, square, and flat steel bars.

TAPS. S. W. Card Mfg. Co., Division of Union Twist Drill Co., Mansfield, Mass. Circular descriptive of Card machine screw taps. Different designs are illustrated, and uses recommended for the various types. The last page of the circular contains a table of A.S.M.E. standard tap drill sizes.

MILLING CUTTERS AND HOBS. Clark Cutter Co., 1304 Harper Ave., Detroit, Mich. Catalogue C, covering the Clark line of cutters, which includes plain milling cutters, side mills, metal-slitting saws, end-mills, hobs, gear-cutters, helical mills, etc. Dimensions and prices are given for the standard cutters.

TURRET LATHES. Jones & Lamson Machine Co., Springfield, Vt. Pamphlet dealing with problem No. 3—chucking work—in a series entitled "The Problems of Your Shop." The present booklet describes the tooling and operations employed in producing an actual part on the J. & L. flat turret lathe.

COUNTERBALANCING DEVICE. Pedwyn Balancer Corporation, 1708 N. Salina St., Syracuse, N. Y. Distributor, Chicago Pneumatic Tool Co., 6 E. 44th St., New York City. Folder illustrating and describing the Pedwyn balancer, a device for suspending, lifting, and balancing electric and pneumatic portable tools, fixtures, etc.

HAMMERS, BOLTS, STUDS, NUTS, CLAMPS, ETC. Victor Products Corporation, 2631 Belmont Ave., Chicago, Ill. Catalogue containing list prices covering this company's line of products, including coupling bolts, studs, thumb-screws and nuts, clamps, hammers, wheel dressers, cutters, soldering furnaces, and screw machine products.

ROLLER CHAINS AND SPROCKETS. Diamond Chain & Mfg. Co., Indianapolis, Ind. General catalogue 57, covering the line of roller chains and sprockets made by this company. Information is given to assist the buyer in selecting and installing correct roller chain drives for different applications, and various installations are illustrated.

LOCK-WASHERS. Shakeproof Lock Washer Co., Inc., 2501 N. Keeler Ave., Chicago, Ill. Circular on "Shakeproof" lock-washers, giving washer numbers for different screw sizes. Actual samples of these washers are being distributed, with the circular, by the agent, the Commercial Tool Co., Plymouth Building, 2026 E. 22nd St., Cleveland, Ohio.

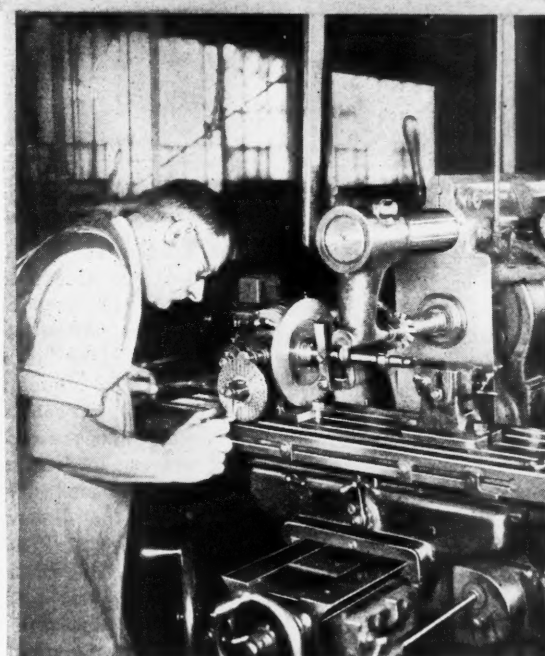
PRESSED-STEEL PRODUCTS. Heintz Mfg. Co., Front St. and Olney Ave., Philadelphia, Pa. Booklet entitled "Common Sense in Steel Dollars," containing illustrations showing the facilities of this company for producing welded pressed-steel parts, as well as some of the products. The booklet gives an idea of the wide field of application for welded pressed-steel parts.

PUNCHES AND DIES. Cleveland Punch & Shear Works Co., Cleveland, Ohio, is distributing a large instruction sheet intended to be posted in the shop, containing points on the proper care of punches and dies, as well as dimensions of this company's standard line of small tools, including punches and dies, and metal-working tools, including punching and shearing machines, bending and straightening machines, etc.

TOOL STEEL. Henry Disston & Sons, Inc., Philadelphia, Pa., have just issued a tool steel catalogue descriptive of the various types of electric furnace tools and alloy steels which they manufacture. These include high-speed, non-shrinking, "fast finishing," hot and cold die, trimmer die, alloy chisel, and standard tool compositions. Information is given on the uses, methods of heat-treatment and physical characteristics of these steels, and tables of standard steel data are included.

ELECTRIC EQUIPMENT. General Electric Co., Schenectady, N. Y. Circulars GEA-67, 263, and 302, describing, respectively, float switches for automatic pumping equipments; "built-in" type KT motors; and variable-voltage vertical squirrel-cage motor for centrifugal drive. Catalogue GEA-257, giving information on representative lines of industrial control manufactured by the company, including rheostats, switches, resistors, controllers, compensators, solenoid brakes, etc. Bulletin GEA-295, describing the application of automatic switching equipment to railway service, hydro-electric generators, mining and industrial service, central station service, etc. Circulars GEA-9 and GEA-255, describing, respectively, gas-engine-driven arc welding sets, and the G-E arc welder—type WD-11—designed for both manufacturing and repair work. Bulletin GEA-54, illustrating a large number of installations of Curtis steam turbine-generators. Bulletin GEA-261, entitled "Electric Heat in Industry," dealing with the advantages of electric heat for various industrial applications.

Optical Methods of Setting Work and Tools



The Use of Optical Instruments in the Tool-room and Shop to Insure Accurate Work

By CHARLES O. HERB

A LARGE proportion of the cost involved in making dies, jigs, tools, and other precision parts is due to the time consumed in setting up the work and cutters to the necessary degree of accuracy. Frequently, the time required for the set-up is much greater than that necessary for the actual cutting operation. Similarly, a large amount of time is often used in setting up machines, fixtures, and tools employed in production work.

Optical instruments have been used in the inspection of finished parts for several years, and have been particularly satisfactory for this work, because they permit such a great enlargement of the surfaces being inspected that inaccuracies can readily be observed by the eye. This successful application of optics in the inspection field led the Bausch & Lomb Optical Co., Rochester, N. Y., to develop a line of instruments based on the same principle, for use in setting up work and tools. These optical instruments enable the ordinary mechanic to make accurate set-ups with convenience, and must not be considered as laboratory tools. Some of their applications will be described in this article. The first of the examples to be presented will deal with the setting up of lathe tools for threading both external and internal work.

In cutting threads in the lathe, accurate work is insured only if the tool is held square with the work so that both sides of the threads will be cut to the same angle with the axis of the work. It is also usually important that the top of the tool point be at the same height as the headstock and tailstock centers. Both of these requirements can readily be complied with by making use of the optical instrument illustrated in Fig. 1, and in addition, the contour of the tool point can be inspected with this instrument.

The body of the instrument has a vee which is clamped on small-diameter work by tightening screw *A* on the side of the work opposite the vee. In the same plane as the center of the vee there is the top of a hardened steel thread gage *B*, which is used to set the tool correctly. The top of this thread gage is placed in the same horizontal plane as the lathe centers by rotating the work with the instrument attached to it, until the air bubble is central in a level vial *C*. Then, with the thread tool loose in the toolpost, the tool is brought forward and the point made to engage the front vee in the thread gage so that it contacts all around. When this has been done, the cutting edges of the tool are in the same plane as the top of the gage and the tool point is at right angles to the axis of the work. The tool is next clamped in the post.

The accuracy of the setting and of the tool point shape can be readily observed through magnifier lens *D*, which is mounted directly over the gage vee and magnifies four times. The magnifier is adjustable to suit the vision of the observer. If white paper is placed beneath the gage, errors of less than 0.0001 inch can be detected by light appearing between the tool and gage edges. When it is desirable to have the top of the tool point 0.001 or 0.002 inch above or below the axis of the work, such a setting can be made. After the setting of the tool has been completed, the instrument is, of course, removed before starting to cut the thread. The level vial is sensitive to 1 minute.

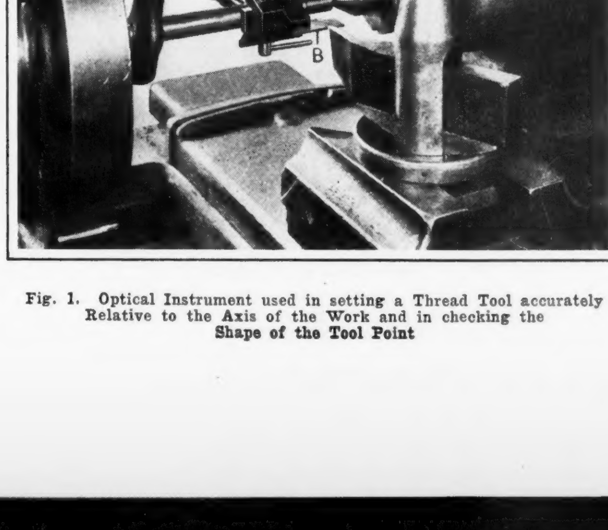


Fig. 1. Optical Instrument used in setting a Thread Tool accurately Relative to the Axis of the Work and in checking the Shape of the Tool Point

Fig. 2 shows the application of this thread tool instrument to work of comparatively large diameter. In this case, the instrument is fastened to the work by means of a link chain attached to an extension spring at the bottom of the instrument and hooked over stud *E* at the top. The spring holds the chain taut to prevent the instrument from slipping on the work. After the instrument has been attached and the top of the thread gage placed in a horizontal plane by rotating the work and observing the level vial, the tool is set as in the previous example. Tools for cutting internal threads in parts can be set by engaging the cutting point of the tool

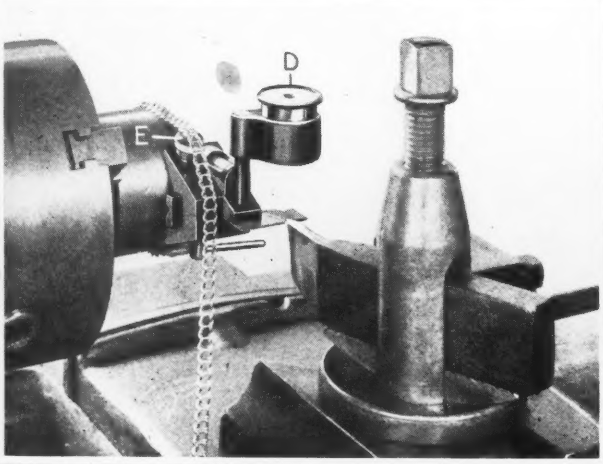


Fig. 2. Application of the Optical Thread Tool Gage to Work of Comparatively Large Diameter

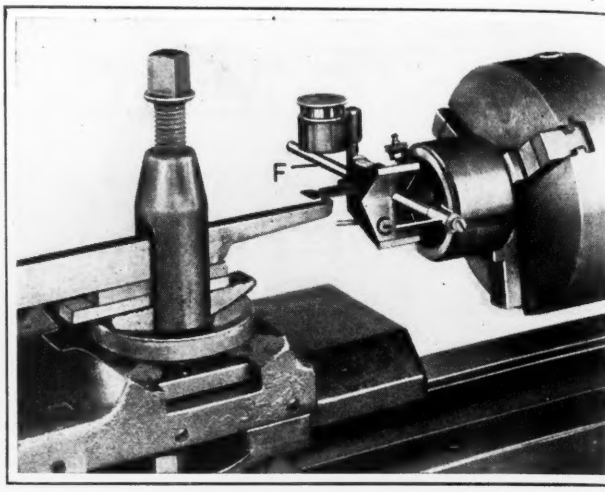


Fig. 3. Applying the Optical Thread Tool Gage in setting a Tool for cutting Internal Threads

in the gage vee opposite that used in setting external thread tools. Magnifier D is then swiveled on its bracket to bring it directly above this second thread gage vee.

There are occasions when internal threads are to be cut in parts having no finished outer surface that permits the attachment of the instrument in the manner described. In such instances, the instrument may be fastened, as shown in Fig. 3, to the finished internal surface on which the threads are to be cut. Rod F is inserted through the center of the body vee, with the instrument keyed to the rod. On the body of the instrument, hardened and ground surfaces are located equidistantly above and below the rod to contact with the finished surface of the work at two points. A third contact is made diagonally opposite these points by means of a small half-sphere attached to sleeve G.

After contact has been made with the work at the three points, a clamp on the bottom of the instrument body is tightened to lock the instrument to the rod F and thus prevent it from shifting relative to the work. A small screw on sleeve G is then turned to adjust the half-sphere firmly against the work. After the instrument has been attached to the work in this manner, the procedure of setting the thread tool is exactly the same as in the cases already mentioned. This set-up of the optical instrument can also be used occasionally for setting external thread tools.

Making Angular Set-ups

The sine bar has been generally used to set up and check the exact angular relation between surfaces, edges, and holes. However, the bevel protractor illustrated at A in Fig. 5 can be conveniently used for this purpose. This instrument has an accurately machined base on which the main body is hinged at B. Swiveling of the body on the base is accomplished by turning thumb-screw C. At D there is a level vial which may be accurately positioned around the circular hole in the center of the instrument by revolving the head E of a worm-shaft. As head E is turned, the worm rotates a graduated dial within the instrument which is attached to the level vial. Clamp F holds the worm in mesh with the graduated dial, and by loosening this clamp, the dial and vial can be quickly shifted a large amount by the handle on the vial housing.

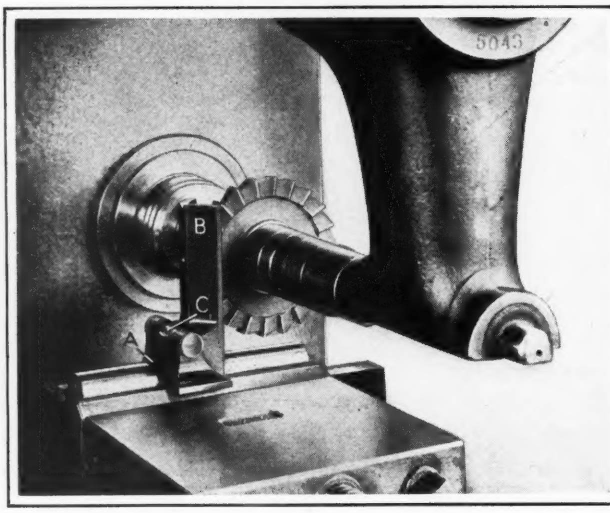


Fig. 4. Locating Cylindrical Work Central with the Axis of a Milling Cutter

The graduations on the dial may be observed through the optical eye-piece G, which so magnifies the spaces between the graduations that a vernier can be read with ease to one minute. The dial itself is graduated to 10 minutes, and every degree line is designated by a number. The graduations are photographically reproduced on the dial with an accuracy well within a minute of arc. The dial is made of transparent glass.

In preparing to determine the relation of an angular surface to a level surface, the head E of the worm-shaft is turned until the dial vernier reads zero when observed through eye-piece G. The instrument is then placed on the level surface, as shown in the illustration. After this, thumb-screw C is revolved to swivel the body of the instrument relative to the base until the air bubble is central in vial D. This adjusts the instrument to compensate for any deviation from a true level in the surface on which the instrument has been set.

The protractor is next placed on the angular surface to be inspected, as illustrated in Fig. 6. Clamp F is loosened to disengage the adjusting worm from the graduated dial, after which the vial and dial are turned as one unit, by means of the vial handle, until the air bubble is once more approximately central in the vial; clamp F is then retightened, and the head E of the worm-shaft revolved until the air bubble is truly central. Now by reading the setting of the dial vernier through eye-piece G, the angular relation of the surface being inspected and the level surface can be determined.

It will be obvious that the relation between angular surfaces can also be conveniently ascertained by the use of this protractor. The instrument has been found useful in checking dovetail surfaces of machine tool slides, in determining the incline of machines, and also in making set-ups on the surface plate, where the sine bar has hitherto been considered to be indispensable.

Locating Cylindrical Work Central with Cutter

In setting up cylindrical work in a milling machine, etc., much time is often taken in obtaining an accurate central alignment of the cutter with the axis of the work and in checking this alignment. An instrument intended to facilitate the setting up of cylindrical work relative to milling cutters, gear-cutters,

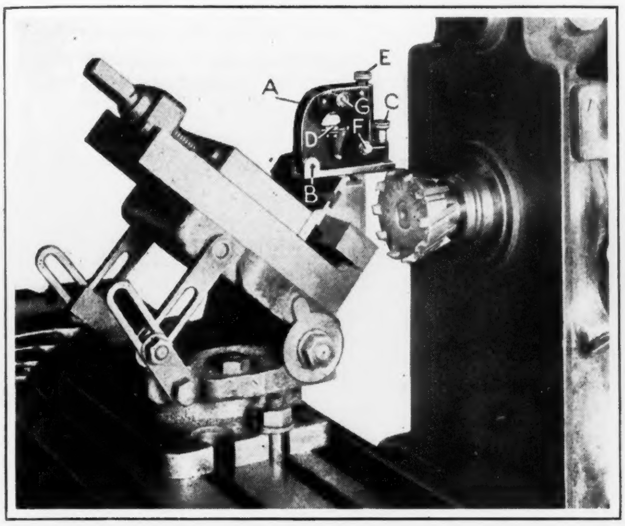


Fig. 5. Employing an Optical Bevel Protractor to determine the Accuracy of a Level Surface

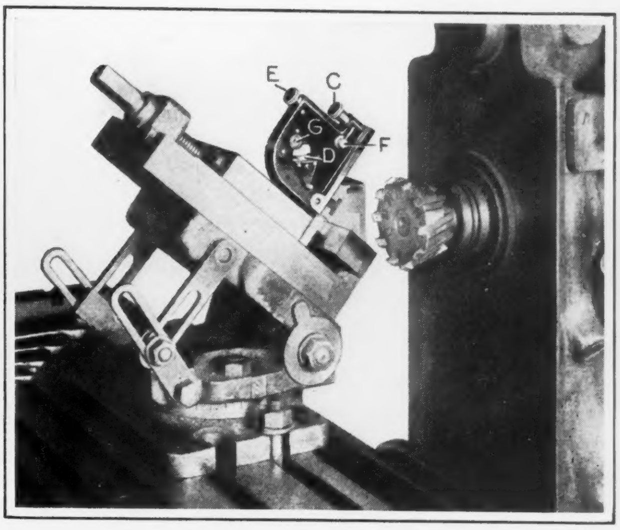


Fig. 6. Using the Protractor to determine the Relation of an Angular Surface to a Level Surface

saws, slotting tools, or drills is shown in Fig. 4. It shows the accuracy of set-ups within 0.001 inch, and can be used for checking the sidewise wabble of cutters within the same degree of accuracy. This instrument is not equipped with optical devices, but has a level vial, and therefore belongs to the same class as the preceding instruments.

The instrument has a horizontal vee *A* and a long vertical vee within upright *B*. Above vee *A* is a level vial *C*, the air bubble of which is observed to determine the accuracy of a set-up. In preparing to make a set-up such as illustrated, the "centering level," as the instrument is called, is placed on the machine table with the upright vertical. If the table is not altogether level, the air bubble of the instrument will, of course, be off center an amount that is readily determined from the graduations on the vial.

After the work has been gripped in the machine vise and the cutter mounted on the arbor, the horizontal vee of the centering level is placed on the cylindrical work with the vertical vee in contact with the cutter teeth on both sides, as shown. The cross-slide of the machine is then operated back or forth until the air bubble of the vial is off center the same amount as when the levelness of the table was being determined. When this position of the air bubble has been obtained, the center of the cutter teeth is in alignment with the axis of the work. In cases where the table is level, the air bubble of the device will, of course, be central in the vial when the work and cutter are correctly set up.

In checking the milling cutter for sidewise wabble, the centering level is placed on a cylindrical object with the vertical vee in contact with both edges of the cutter, as described before. The air bubble is observed to determine the greatest amount that the instrument tilts, while the spindle with the cutter is gradually rotated by fractions of a revolution. It is thus possible to determine the position of the cutter edges that are registering the greatest deviation from the true cutter plane.

When it is necessary to drill a hole in the center of a cylindrical piece, the table of the drilling machine is inspected for levelness by applying the instrument as already mentioned, and then the sides or the top of the upright vee is brought in contact with the periphery or point of the drill held in the spindle of the machine. To bring the center of the work directly under the axis of the drill, the work-table is moved in or out until the vial reading is the same as in the inspection of the table. The horizontal vee of this instrument is applicable to work up to 6 inches in diameter, while the set-up of cutters up to 1 inch wide can be inspected by means of the vertical vee. For cutters of small diameter, a block containing a small V-groove that accommodates cutters up to 1/8 inch wide is attached to the upright vee. By the use of this auxiliary block, the set-up of small-diameter cutters can be conveniently inspected without the outer edges of the vertical vee touching the cutter-arbor.

The sensitiveness of the centering level depends upon the distance from the center of the cylinder on which the gage may be placed, to the points of contact with the two cutter edges, and upon the sensitiveness of the level vial. The level provides a handy means for setting up a machine accurately in a few seconds.

Dividing Circles Within Ten Seconds of Arc

In manufacturing gears in which the circular pitch between all teeth had to be accurate within 10 seconds at the Bausch & Lomb plant, it was found necessary to develop an optical indexing device for application to dividing heads, as shown in the heading illustration and in Fig. 7. This device consists of a microscope *A*, Fig. 7, a graduated disk *B*, and a lamp *C* for illuminating the graduations on the disk. The microscope is provided with a rectangular prism at the eye end for the convenience of the operator. This prism can be swiveled into such a position that the observation can be made from the side, from an inclined position, or from the top. There are three graduated circles on disk *B*, one being graduated into 720 divisions, and the others into 770 and 800 divisions, but any other number of graduations can be used for special purposes.

The disks are graduated on an accurate circular dividing machine in the same manner as the graduated circles on surveying and engineering instruments are made. The disks are made interchangeable, and can be attached

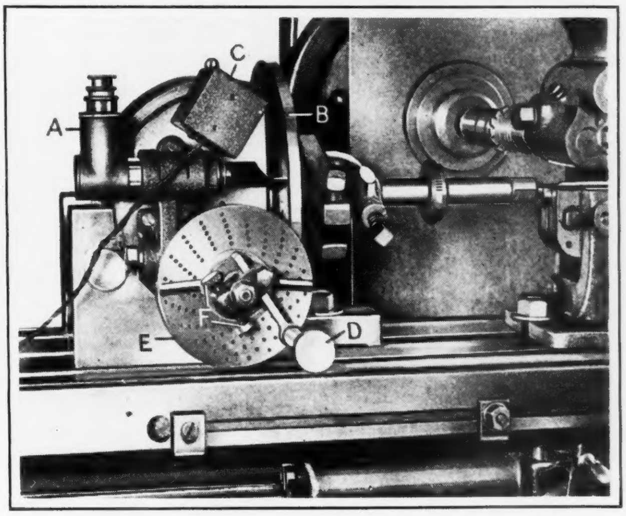


Fig. 7. Dividing Head provided with Microscopic Equipment and a Graduated Disk, for obtaining exceptionally Accurate Settings

whenever required or transferred to another dividing head at any time.

In using a dividing head equipped with this optical device, the work is attached to the dividing head spindle in the regular manner, and indexed by turning handle *D* until the proper graduation on disk *B* coincides with the index line of the eye-piece attached to microscope *A*. The spindle of the dividing head is then locked by means of the spring plunger in crank *D*. When this plunger is not directly over a hole in plate *E* after an indexing has been accomplished, adjusting screws *F* are turned to swivel crank *D* independently of the dividing head spindle and the work, a sufficient amount to bring the plunger of the crank directly over a hole in plate *E*. By looking through the microscope eye-piece at the graduations on disk *B* while locking the dividing head spindle, any change in the setting of the work can readily be observed.

In machining metal having hard spots, the cutter will sometimes cut unevenly and cause the dividing head spindle to shift slightly. If an accurate gear or similar part is being produced when this occurs, there may be an appreciable error between the last and first teeth cut. With this optical device, however, such errors can be obviated by observing each setting before starting the cut and before indexing for the next cut. Dividing heads equipped with this optical device have found numerous other applications than on milling machines. For instance, they have been advantageously used in boring the bearings of multiple-spindle heads.

Mounting the Dividing Head Optical Device

Disk *B* is mounted on the regular disk of the dividing head spindle, the latter disk being first milled on the periphery to suit the bore of disk *B*. A slight milling cut should be taken on the regular dividing head disk while in place on the dividing head, by means of a cutter on the arbor of the milling machine on which the dividing head is to be used. Also, before milling the disk, any play of the dividing head spindle should be corrected. These precautions will insure concentricity of the graduations on disk *B* with the spindle of the dividing head.

The microscope is fastened to a small bracket that is readily doweled and bolted to one side of the dividing head. After loosening the bolt, the microscope can be shifted up or down to bring the required graduated circle in the center of the field of view. In setting up this unit, the illuminator end of the microscope is placed against the adjacent face of disk *B*, with a piece of bond paper between them. Then the bearing of the bracket is clamped on the microscope to hold the latter in place, after which the bond paper is removed, leaving a space of from 0.001 to 0.0015 inch between the microscope and the disk. This simple method of setting up the microscope insures the proper focus of the disk graduations when viewed through the eye-piece, which is sometimes difficult of attainment with optical instruments. When the dividing head is also used for cutting bevel gears, etc., the microscope can be tilted with the dividing head after the spiral gear attachment has been removed.

Straight-line Indexing

Microscopes similar to those used on the dividing heads may also be employed with straight graduated bars for indexing gear racks, parts to be grooved, and similar work, where accuracy of the divisions is imperative. The microscope is held in a double link that is fastened to a bracket clamped to the column of the machine. A master bar with graduations suitable for the operation is clamped to one slot of the machine table, in such a manner that the graduations can be observed through the eye-piece of the microscope.

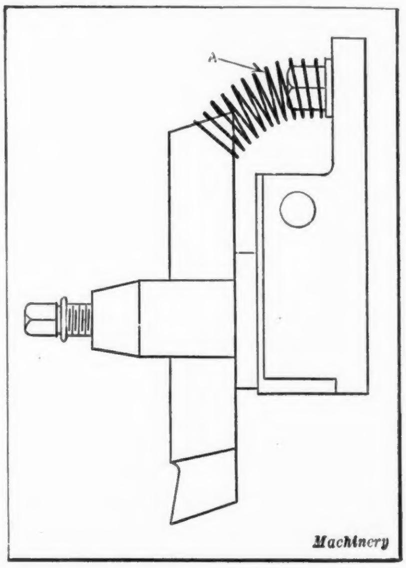
In starting an operation with this equipment, the cutter is set relative to the work for cutting the first tooth or groove, and the microscope is locked above a certain graduation. After the cut has been taken, the same graduation is observed to make sure that the table has not shifted longitudinally during the cut, and then the table is moved to bring the succeeding graduation under the microscope. The graduated bar is made of German silver, and the graduations are about 0.001 inch wide. These lines can easily be located beneath the microscope within 0.0001 inch. It will be obvious that this method eliminates all errors in work due to inaccuracies in the lead-screw of a machine.

* * *

TAKING INTERRUPTED CUTS ON A SHAPER

By DONALD A. HAMPSON

In cutting across an interrupted surface with a shaper tool, the succession of cuts quickly followed by gaps makes it difficult to obtain a level surface. The tool-block of the shaper is much lighter than that of the planer, and its fit on the vertical slide is normally kept in freer adjustment. The result of this is a jar and a clatter that is not produced in machining the same part on a planer. This jarring often causes the head to move vertically and the tool itself to shift in the holder.



Shaper Tool-block equipped for taking Interrupted Cuts

Such intermittent cuts are required most frequently in machining castings. The tool bumps into the metal, and before it has time to seat itself, it is through, snapping out of the far side with force enough to cause the clapper-box to fly up from its seat, and perhaps to return again before the next metal part is reached. Often, however, it drops down on top of the metal, in which case it must force its way in while going forward. The latter condition causes the position of the tool to change and results in an uneven surface on the work.

In a shop in the Middle West where considerable work of this kind is done, it has been found worth while to use the simple scheme shown in the accompanying illustration for holding the tool to its seat. A coil spring *A* is placed between the shank end of the tool and some stationary part of the head. This spring is not so stiff as to prevent the clapper from working, but it is strong enough to keep the tool in contact with the work the full length of the forward cut. This effectively prevents rebound and enables a much higher cutting speed to be employed. It also helps to keep the tool edge in good condition.

* * *

INCH MARKS ON DRAWING DIMENSIONS

By C. W. PUTNAM

In an article entitled "Inch Marks on Drawing Dimensions," on page 486 of February MACHINERY, the advantage of placing the inch marks in the conventional position rather than over the decimal point, as advocated by one writer, was pointed out. The present writer believes that the generally accepted practice is the better of the two methods. We might ask: Why use the decimal point at all? Why not write $2\frac{500''}{1000}$ on the tracing instead of 2.5"? One concern the writer worked for, found there was less chance of mistakes being made when this method was used.

Overhead and Burden in the Machine Shop

How Overhead Expenses and Burden are Determined and Distributed in a Manufacturing Plant

By JAMES ALLEN THOMAS

OVERHEAD expense is that part of the cost of operating a plant that cannot be directly charged to productive work. For example, it covers such items as repairs, crane operation, foreman's wages, oil, waste, light, heat, power, and all expenses that are of a general character. "Burden" is a division or unit of overhead calculated into a convenient form for adding to material costs or labor costs, so that when added to them, it will give a total that will represent the cost of a job.

There are two generally accepted ways of apportioning the overhead and arriving at the burden to be added to the wages. Some cost accountants prefer a percentage basis, and others a rate basis. There are arguments in favor of both methods. The writer believes that the rate basis will give the most accurate results and the most equitable distribution of the overhead.

James Allen Thomas*

Rather than charge to labor, overhead expenses that may be incurred in the handling of stock materials, such as unloading, warehouse expenses, and cost of distributing materials to the departments where they are used, it may be advantageous to have a "material burden." This burden will cover all costs of handling material that cannot be charged to the job on which the material is used. When the freight and miscellaneous charges cannot be conveniently calculated and added to the item of material, they may be placed in the material overhead, and thus will be reflected in the material burden.

Cost Basis and Pound Basis for Adding Material Burden

The burden to be added to the cost of the material may be added on a percentage basis, but some discretion must be exercised in the selection of the manner in which this is to be done. The cost of the material will be the invoice price, plus the freight and other charges, when it is convenient to calculate these, plus the material burden.

An example of the disadvantage of adding a material burden on a percentage of cost basis presents itself when it is considered that it is obviously not so costly to handle a hundred dollars worth of babbitt metal at a price of forty cents per pound, as it is a hundred dollars worth of bar iron at two cents per pound. Unless the class and price of material handled is quite uniform, it might be best to add the material burden on a pound basis. Here is a place where the common sense of the cost accountant must enter into the equation.

Whichever method is selected as being more suitable, that method must be adhered to, as more than one system of adding burden cannot be used in the same cost system. A burden to be added to the material is not so necessary in the cost system of a plant where no crude or raw material is sold, or where the material is an insignificant part of the total cost of a job. But if the raw material is a large part of the cost or raw material with no workmanship added to it is sold, a material burden is very necessary.

Keeping Track of Overhead Expenses

A very careful and accurate account of all expenditures for overhead expense should be kept, and it should be available for the inspection of the heads of departments at all times. This account should be kept in the cost department, and it should be the duty of the head cost accountant to call the attention of the heads of the different departments to excessive items of expense as they occur. This will have an influence in keeping these expenditures down to or as near their normal amount as possible, and in finding ways to reduce them.

In the list of overhead items, must be included everything that cannot be directly charged to productive work or to jobs that are to be paid for by a customer. It may be expedient to take into consideration the space occupied by the different departments, the value of the individual buildings, etc. This will cover interest on the capital invested in the department or its existing value, taking into account the previous depreciation.

Some of the items of overhead that will require discretion in handling will be depreciation of plant, interest on value of land occupied, repairs, and improvements. Depreciation as it is written off will tend gradually to lessen the overhead; increase in land value will have the opposite effect. Both of these amounts reach the overhead account through the capital account. Repairs will usually go into the overhead directly, but improvements may get there directly or through the capital account.

Principles Governing Distribution of Overhead Expense

It will largely devolve upon the management to decide what items are to be considered as overhead, and the amount of these items, but they are usually taken into account in any proper bookkeeping system. When range of size, cost, space occupied, and power consumed by different machines is wide, it is advantageous to take these factors into consideration. It is not advisable to carry this to too fine a point, however, as it tends to make the system of adding the overhead cumbersome, and increases the liability of

*J. A. Thomas was born in 1872. At the age of sixteen—in 1888—he started as a machinist's apprentice with the Webster, Camp & Lane Machine Co., Akron, Ohio, becoming a journeyman four years later. After working at the trade for about four months, he went into the drafting-room, studying drawing and mathematics at night. In about a year he went to Fraser & Chalmers, Inc., Chicago, Ill., in charge of the design of hoisting machinery. It was here that he first took an interest in cost accounting, his work requiring the making of estimates, and he devised a cost system that was later installed in that plant. For five years, he continued his work as designer and engineering salesman of this company, and later at two different times, for short periods, he was superintendent of the company's Twelfth St. Shops, employing from 600 to 800 men. In 1901 Mr. Thomas went to the Pacific Coast, for three years acting as engineering salesman for several machinery builders. In the latter part of 1904 he went to South America, and during his six years there acted in the capacities of manager, engineer, and superintendent of machinery for various large mining companies. Later he spent six years in Mexico in the same capacities. For the last five years he has been engineer and salesman for the Llewellyn Iron Works, Los Angeles, Cal. This is one of the largest steel and machinery concerns on the Pacific Coast, employing at times as many as 1500 men.

mistakes being made. The thing desired is to get the overhead equitably apportioned to the work and take into consideration the size, class, and kind of work. Different departments will have different amounts of overhead in relation to the productive labor, and consequently different rates of burden.

When a manufacturing establishment is composed of several departments, it may be advisable to obtain a burden for each department, and then a general burden must be ascertained which will be applicable to all departments of the plant. The general expense consists of such items as office salaries, maintenance, income taxes, traveling and selling expenses, cost-keeping, etc. The department burden and the general burden added together will make the total labor burden for a department, and when added to the labor cost and material cost, plus material burden (if a material burden is used) will give the total cost of the job. The result will not be absolutely accurate, for absolute accuracy cannot be obtained, there being no way of dividing the overhead expense and apportioning it to the work with absolute precision. A very close approximation, however, may be reached, and this is of sufficient accuracy for all practical cost purposes.

The rate per hour basis for adding burden is preferable for many reasons. For instance, it costs as much to provide operating facilities for a man who receives a low rate of pay, as it does one who receives a high rate, and the low-rate man may be doing some of the best work or running one of the most costly tools. If the burden is to be on a percentage basis, it will be obtained by dividing the non-productive expense or overhead by the total productive expense. If it is to be on a rate per hour basis it will be determined by dividing the overhead by the total number of productive hours of labor. Non-productive hours must not enter into the divisor; productive wages must not enter into the dividend.

Why Overhead Should be Based Upon Average Conditions

When the rate of overhead or burden is allowed to fluctuate very much, it will be reflected in the cost of jobs that were estimated with one rate of burden and done later under another rate. The result will show either a loss, a smaller profit than calculated, or an abnormal profit, depending upon which way the burden moved between the time of estimating the job and the time of doing the work. Also, let us assume that the burden is determined from overhead and labor over a short period. As long as the plant operates on a normal quantity of production, no effect will be noticed, but when slow times come along and men are laid off, the productive hours become less, while the overhead continues at about the normal rate. This will raise the burden, and when used for estimating purposes, it will make prices unusually high, and consequently may be the means of losing some valuable contracts.

For these reasons, it has been found advisable to use a long period of time covering expenses and productive hours of labor as a basis upon which to compute the overhead rate. The period of time over which the rate of overhead is computed should be as long as is necessary to give a fairly close average quantity of production and an average of total overhead expenditures. It should be a long enough period to take in some of the dull times as well as some of the prosperous times of business. This will keep the rate of overhead line flat and not permit it to fluctuate too widely. This is assuming that the rate of overhead is calculated at definite intervals, as it should be.

How Shop Executives can Reduce Overhead

Within certain limits, the manager and foremen have no control over wages or overhead, and the foremen certainly have no concern or worries with the latter in so far as the general overhead expenses are concerned. It is not to be inferred from this that the foremen or manager are entirely free from control over the amounts that are spent for the overhead account. They have the greatest influence over the items of expenditure that are not directly chargeable to orders, but they have no control over items that have already been charged to overhead, thus affecting the shop's current rate of burden. The rate of overhead has been fixed for the current period; hence the shop executives are left with only the time to be charged to orders and the items that go to make up the future overhead to be influenced by the management.

If some check is not kept on these items and attention directed to abnormal and extravagant amounts, it will be surprising how much wastage will take place in such accounts as oil, waste, files, power, light, and items that are small but occur at frequent intervals. The foremen are the only ones who can restrict wastage in such items, and they should be held just as accountable for wastage in such cases as they are for waste of time.

There is no intention of conveying the idea to the reader that the cost result thus obtained is the proper one to which to add a percentage of profit in charging for the work. The correct and proper charge for the work is a separate and distinct matter, and should take into account some consideration of the value of the machine upon which the work is done, and its particular adaptability and efficiency.

Burden for Estimating Purposes

When the burden changes radically through the effects of slack times and business depression, it will be due to the overhead expense remaining normal and the number of hours of productive work falling off, or vice versa. Now when this burden is used in the calculations of costs for estimating purposes, if the burden has increased, it will increase the estimated costs and make work harder to get, and this happens at a time when the shop most needs the work. On the other hand, if the shop has been extremely busy in the past, and the burden is reduced, the estimates will be based on a low burden, and the shop will be flooded with work at a low price, while other shops may be getting a higher price.

This is evidence that the burden should remain as near even as is consistent, and should not be allowed to fluctuate very much. If some radical changes have been made in the methods of administration of the plant, or something has been done that will permanently affect the overhead, this must be taken into account so that the burden will include it. It should not be considered inconsistent if an arbitrary high burden is established for estimating purposes in order to take advantage of a seller's market. Likewise, it should not be considered inconsistent if an arbitrary burden is set low in order to stimulate business so that low prices may be quoted. These remarks are not intended to mean that changes should be made in the burden for cost-keeping purposes, but only for use in adding burden when estimating on work. For estimating purposes, the burden may have to be a little elastic; such elasticity is purely arbitrary and in the hands of the management of the business.

It may be argued that a change in the percentage of profit to be added to the estimated cost should be made, but that will not always cover the case as, for example, when it is necessary to quote prices below the total cost in order to get work so that the organization may be kept together. Under such circumstances, it is better to get part of the overhead than none at all, as would be the case if the job were lost.

* * *

Greece is passing through a rather remarkable industrial development, and the imports of machinery into that country in 1925 were about 50 per cent larger than in 1924. Several new industries have been introduced into the country for the first time, and this has resulted in the purchase and installation of a great deal of new machinery. Most of the imports came from Germany, with Great Britain second and the United States third. The preference for German machinery, according to the Department of Commerce, is due to its cheaper price. American machinery is admitted to be superior in quality, but as the prices are from 25 to 50 per cent higher than the German prices, sales are limited.

End-Knurling Tool for Screw Machine

By HENRY SIMON

WHILE end- or face-knurling is based upon the same general principles as other forms of knurling, a totally different set of problems is involved in designing the tool equipment. Though it may be relatively easy to face-knurl a narrow margin or ring, the area of which is small compared to the total end surface, the difficulties increase in geometrical progression as the extent of the surface to be knurled increases in proportion to the entire surface. How an unusual face-knurling operation was performed on an automatic screw machine is described in this article.

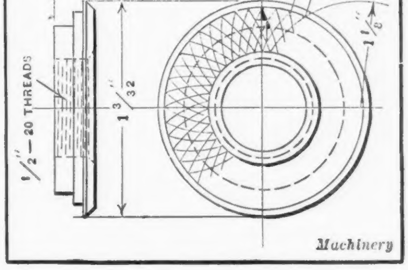


Fig. 1. Nut to be face-knurled

The steel nut shown in Fig. 1 was to be knurled as shown, the knurling occupying nearly three-fourths of the cross-sectional area of the stock. The product was to be high grade, and it was therefore necessary for the knurling to be clean cut and as nearly perfect as possible. Production of the knurling on a press had been considered, but it was finally decided to perform the knurling operation on the screw machine.

It therefore became necessary to design a tool for use on the automatic which would do this work in a satisfactory manner. Accordingly, the tool shown in Fig. 2 was developed for use on a 1 1/4-inch Cleveland automatic screw machine. In view of the many elements of uncertainty in the case and the small amount of information available on such work, it was decided first to produce the knurl roll, and after bringing it to the point of reliable performance on the lathe, to complete the design of the machine holder.

Making the Knurls

The first step was the production of the master knurl shown at *A*, Fig. 3. The design on this knurl is a replica of that on the finished product. A good grade of water-hardening steel was used for the master knurl, and care was taken to produce a perfectly smooth and sharply cut design, with the surfaces of the teeth at right angles to each other.

The next step was the production of the knurl blanks, which were made from the same grade of steel as the master knurl. These were made in the form of a cone having an included angle of 60 degrees. At the same time it became necessary to have a device in which these blanks could be rolled on the lathe, and to this end the tailstock holder shown in Fig. 4 was made. As will be seen, it has a head *A* which is slotted across its face to receive the knurl carrier *B*, the latter being made from a piece of flat tool steel. Set-screw *C*, acting upon a lock plug *D*, locks the carrier at any desired angular or up-and-down adjustment.

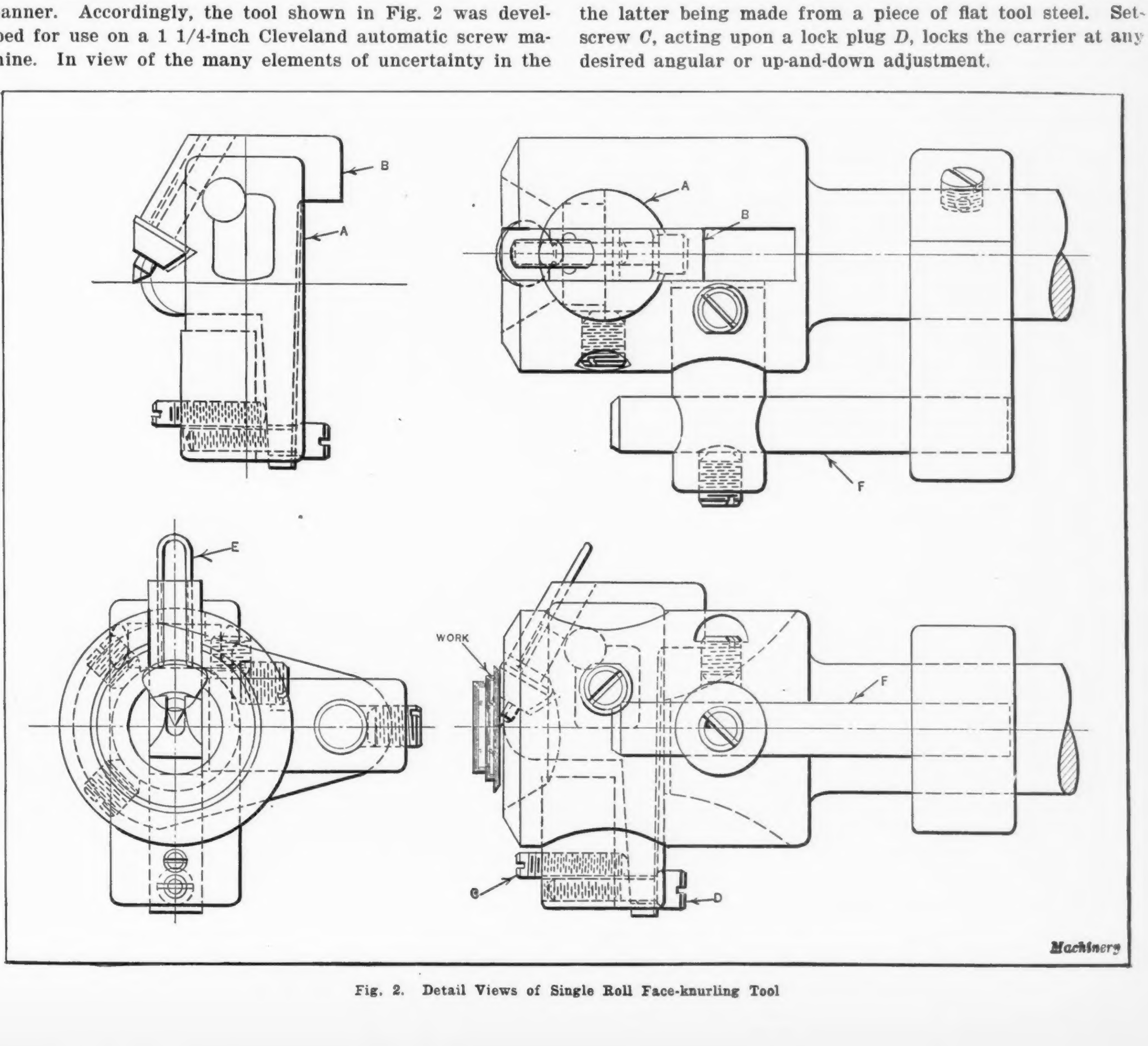


Fig. 2. Detail Views of Single Roll Face-knurling Tool

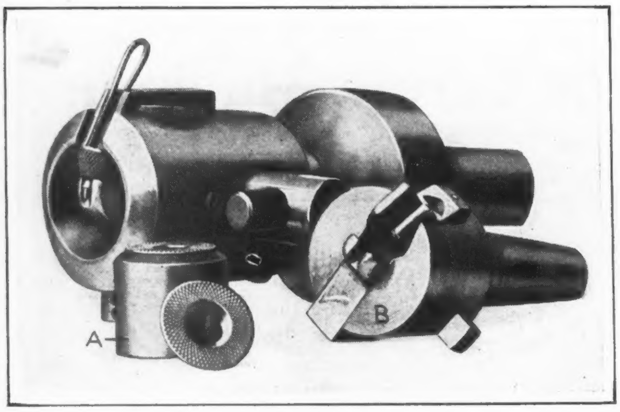


Fig. 3. Knurling Tools and Master Knurl

Only a small amount of trial work was required before the first perfect knurling rolls were produced on the lathe. The knurl design was rolled on the conical surfaces of the blank rollers by mounting them in the holder shown in Fig. 4 and bringing them into contact with the rotating master knurl held in the lathe spindle. The knurl rollers thus produced were heat-treated in the usual manner. They were then mounted in the lathe holder and tried out on a piece of stock held in the lathe chuck. This trial proved that they were capable of producing a perfect job. As was to be expected, however, it was also found that this was a delicate operation, and that minute variations in the location or inclination of the roll would cause "crossing" or doubling, or would tear off the design. It therefore became clearer than ever that the machine tool-holder, to be successful, must be provided with independent angular and up-and-down adjustments, and that it must rigidly maintain its position.

Developing Knurl-roll Holder for Automatic

The holder shown in Fig. 2 was developed on the basis of the experience thus far gained, and with it a considerable number of nuts were made. As will be seen, the idea underlying it is roughly the same as in that of the simpler lathe holder shown in Fig. 4 and at *B*, Fig. 3. The knurl-roll carrier consists of two main parts. One is a cylindrical plug *A*, Fig. 2, passing transversely through the head of the tool, which permits radial adjustment of the roll. This adjustment is securely held by means of a set-screw. Let into this plug and pivoted in it is the knurl-roll carrier *B*, its limited rocking movement being accurately controlled by means of a set-screw *C* and lock-screw *D* located in the tail of the carrier, where they are readily accessible for adjustment. At the opposite end, the carrier proper is widened in front to carry the knurl roll just beyond the confines of the head, and it also extends similarly behind, the two projections keying the carrier into a slot formed in the head.

It will be noted that the knurl roll is supported both above and below its working surface, in proportion to the thrust developed, some of the thrust being also taken by the back face of the knurl-roll cone. The open-front construction of the knurl-roll bearing, which is necessary in order to admit the knurl roll, also solves the problem of ready removal and changing of the roll in the course of the work. As a matter of fact, no fastening means other than a spring-wire clip *E*, which takes a light hold in two small grooves formed in the upper knurl-roll seat, is employed. This is necessary only to prevent the knurl from dropping during the indexing of the turret, and permits the removal, inspection, cleaning, or replacement of knurl rolls without stopping the feed mechanism of the machine while it is in operation.

With the machine thus equipped, several thousand parts were made, but it appeared that there was still a rather heavy loss due to defective, crossed, or rubbed-out knurling, which was reflected in burned, filled-up, or damaged knurl rolls. Observation showed this to be due largely to the occasional springing of the knurl tool. It was therefore decided to use the front cross-slide to carry a steadyrest for the knurl tool, and so the steadyrest holder *F* was added to the tool. As will be noted, this can be adjusted forward and backward along the tool. This holder engaged a simple steadyrest made from a block of cold-rolled steel carried on the front slide of the machine. With this arrangement, very few parts were spoiled—only about 7 per cent.

Preparing Work for Knurling

It should be mentioned that one important and, in fact, indispensable element in the success of the knurling operation was the forming of an accurately located and smoothly finished surface for the knurl tool to work upon. As the smaller diamonds were only about from 0.012 to 0.015 inch high, it will be easily seen that a variation of as little as 0.003 to 0.004 inch in the location of the blank surface relative to the chuck would cause a disastrous pressure from the advancing turret, which would be likely to cause the face to be ruined or torn from either the product or the knurl roll, or both. This contingency was taken care of by the provision of a double-bladed facing tool, which immediately preceded the knurling, and therefore allowed no disturbing influence of any kind to interfere between the two operations.

Design of Improved Tool

While the tool just described did creditable work, it became clear that better results could be obtained by improving the design, and with the experience gained, the improved end knurl shown in Fig. 5 was designed. About the time the design had been completed, changes were made in the product for which the knurled nut was intended, which eliminated the nut, and therefore the new tool was never actually constructed. In view of the measure of success attained with the first tool, which seemed to justify the reasoning employed in its construction, it is believed that the new design, with perhaps some modifications suggested through extended use, would have proved thoroughly satisfactory. As it embodies some unusual features believed to be interesting quite apart from their application in this particular device, it will be worth while to examine the construction in detail.

Three important points that were kept in mind in designing the improved tool were first, to reduce to a minimum the loss arising through defectively knurled parts; second, to lengthen the useful life of the knurl rolls; third, to make all adjustments entirely independent of each other, and to render them positive and instantly made. Some modifications of a lesser nature, more especially saving of space, had to be taken into consideration because of the fact that the new tool was to be adapted to a No. 2 B. & S. automatic.

Experience with the tool shown in Fig. 2 had shown that, in addition to other adjustments, it was desirable to provide means for accurately centering the tool in the turret, or else for readily setting the knurl roll off center by a small amount,

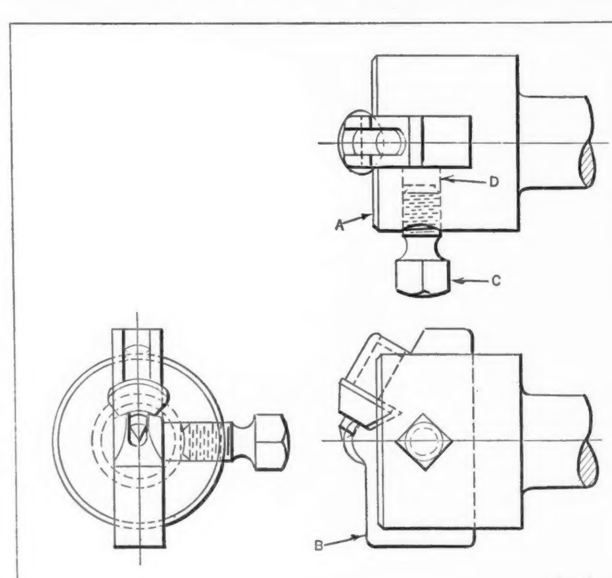


Fig. 4. Knurl-holder used in Lathe

in order to avoid or compensate for the effects of the side throw resulting from the forcible rolling of the end of the stock against the knurl. The tool shown in Fig. 5 was therefore designed to be of the floating holder type, to permit any desired adjustment of this nature.

Attached to the conventional base by four cap-screws is the main body of the tool *A*, which consists of a piece of round stock flattened to a roughly rectangular cross-section, and in which is contained the entire mechanism of the tool. Two deep and wide slots running lengthwise through opposite high sides of the block and meeting in front, contain the knurl-roll holders *B*, each shaped to hold a knurl in front in the same manner as the old tool, and otherwise so formed as to leave as large a solid center section as possible in the body *A*. A refinement is the addition of a thrust washer *C* back of the knurl-roll cone in order to minimize friction and wear on the knurl-holder.

Adjustments Provided

The position of the knurl-holders *B* in their slots is determined by means of the knurl-holder rocker *D*, and by the differential screw *E* and nut *F*, the former influencing the longitudinal and radial position of the knurl rolls, and the latter the inclination of the face of the knurls relative to the face of the product. Considering the first of these features in more detail, it will be seen that the knurl-holders have a shallow groove formed on one side, near their front ends, concentric with a point located on a line at right angles to the sides of the holders and passing through the apex of the knurl roll.

The rocker *D*, located in a shallow depression formed on one side of the body block and having a limited movement on its pivotal screw *G*, engages these two grooves snugly through two hardened tool-steel pins *H* set into two bosses in the bottom of the rocker, holes slightly larger than the bosses allowing the latter to pass through the body of the tool. A clamp-screw in the tail of the rocker enables it to be locked at any point of its movement, while a set-screw *I*, bearing against one side, makes it possible to depress the tail and force one knurl into the work ahead of the other.

The use of the differential screw and nut offers what is perhaps an unusual application of this device, it being employed in this case to vary the angle between two members, the ends of which must remain on a common center, while they cannot be connected or pivoted. The differential arrangement consists of a main adjusting screw *E*, having a stem with two different threads, the larger of which runs in a central hole through the body *A*, while the enlarged head spreads the rear ends of the knurl-holders. Upon its front end the stem carries the nut *F*, which is held against turning by a pin-key *J* engaging a keyway formed on the front end. The key *J* is slightly sprung to make it tight in its hole and tapped to permit it to be readily removed.

To allow the adjusting screw to be turned, the head has a series of pin-holes formed in its periphery, these being made accessible through a large opening milled in the body on the side opposite the rocker. A secondary but indispensable part of the adjusting mechanism is the clamp *K*, consisting of a long screw passing through one side of the body, which exerts a pressure through its nut and spring cup, upon two clamps *L* which, in turn, rest upon balls located in depressions in the knurl-holders.

The main reason for providing two knurl-holders in this design was that it was believed that better results could be obtained by employing two single-cut knurls instead of one "net-work" roll. The second knurl-holder neither complicated the design nor would it have unduly increased the cost.

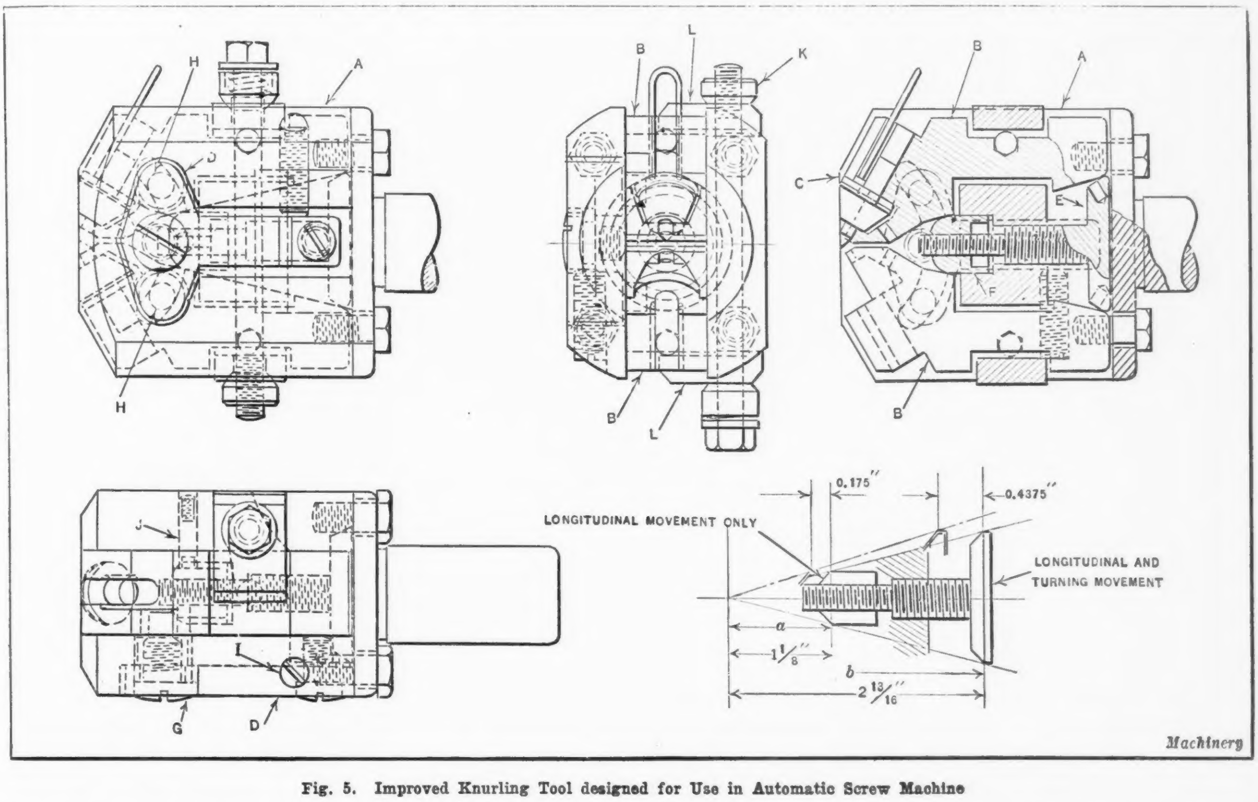


Fig. 5. Improved Knurling Tool designed for Use in Automatic Screw Machine

It will be noted that the new tool preserves intact every advantage of the old design, and that it can, like it, be used with a single knurl roll by simply leaving one holder empty. To the advantages of the old tool, however, some very important features are added. One of these is the floating adjustment. This actually lowers the cost of constructing the tool through the elimination of much of the fine work required in maintaining a given center. The lower cost is of less importance, however, than the advantages of adjustability, for after the correct theoretical center has been obtained in a solid tool, it is still questionable if this center and the actual working center of the tool under the torsional stress of knurling would be the same, and it would certainly be likely to change with wear. Equal in importance to this adjustment is the ready and positive screw adjustment of the knurl rolls without disturbing the location of the apex, in contrast to the old tool, where each angular adjustment of the roll also brought its point into a new position which had to be corrected.

The differential ratio between the relative movement of the nut and screw toward the point of the knurl was in-

tended to be 1 to 2 1/2, which is represented in this case by 30 threads per inch on the nut, and 18 threads per inch on the main screw stem. As this might be varied and as it is easy to become confused on differential movements, a formula is given for this type of differential arrangement.

To find

x = required number of threads on nut

where

y = known number of threads on main screw stem;

a = (variable) distance between nut and pivoted point of knurls; and

b = corresponding (variable) distance between nut and screw head.

$$x = y \frac{(a + b)}{b}$$

Both threads must be either right- or left-hand.

It will be seen from a consideration of the construction of the knurl-holder adjusting system that if, for any reason, variations of the knurl rolls from the exact center position should be desired, this can be easily effected by simply disengaging the key and giving the nut a half turn or so forward or back, then reengaging the key and thereby varying the location of the apex of the knurl rolls without noticeably influencing the correct operation of the differential. This is very desirable for reasons cited before in favor of the floating arrangement of the head, namely, to compensate for inaccuracies in machining and assembling the tool parts, to establish the actual working center, and to offset the results of wear on the knurl-holders.

For similar reasons, the adjustments afforded by the rocker arm would be valuable, especially because of the possibility of restraining a faster cutting knurl from doing too much work. The construction of the lock-bolt assembly renders possible either the automatic and continuously self-adjusting adaptation of two knurls to the work under tension of the spring, or the positive locking of both holders in a position that has been proved correct.

* * *

LEATHER BELTING INVESTIGATIONS

A report has been issued by the Leather Belting Exchange Foundation at Cornell University, Ithaca, N. Y., on experiments to determine the relative power transmitting capacity of belts on vertical, angular, and horizontal drives. The report is prepared by R. F. Jones, research engineer, and copies may be obtained from the Leather Belting Exchange, 417 Forrest Building, 119 S. 4th St., Philadelphia, Pa. A summary of the results and conclusions is given in the following:

1. The vertical belt transmitted about 12 per cent less power under average conditions than the horizontal belt at 7 feet 6 inches center distance. The percentage difference varies somewhat with the center distance.

2. A given increase in tension increases the capacity of a vertical belt more than it does that of a horizontal belt, and vice versa. Therefore, a vertical belt is more sensitive to tension, and ought to be retightened a little oftener to maintain an equally uniform transmitting capacity.

3. At the higher tensions, vertical, angle, and horizontal drives perform more nearly alike, while at low tensions they are widely different in transmitting capacity.

4. The power transmitting capacities of four drives with the tight side below, fall in the following order: First, horizontal belt; second, 45-degree belt; third, 67 1/2-degree belt; and fourth, vertical belt. There is practically no difference between the horizontal and 45-degree drives or drives in between these two, except at low tension, when the horizontal is better.

5. Comparing the effect of using the tight side above and below with 45-degree and 67 1/2-degree belts, it was found that when the tight side was below, leather belts gave about 12 per cent more power on the 45-degree drive and about 6 per cent more power on the 67 1/2-degree drive, under average operating conditions.

PROGRESS OF THE MOTORSHIP

The recent inauguration of transatlantic motor passenger service has directed general attention to the increasing importance of the motorship as a factor in ocean transportation. The internal combustion engine, by its fuller utilization of fuel energy, is testing the supremacy of the steam engine as a prime mover on the seas. As yet, motorships do not carry more than a small proportion of the world's ocean freight, but their efficiency and relative economy have been thoroughly demonstrated, and motorship construction is increasing rapidly.

A motorship, according to *Commerce Monthly*, is usually defined as any vessel 100 gross tons and over in size, propelled by internal combustion engines. The tonnage of motorships building in the world has risen from 8 per cent of the total in 1921 to 49 per cent in September 1925, all but equalling the tonnage of steamships under construction.

Motorships suffer in comparison with steamships in the matter of capital investment. The initial cost of installing an oil motor of medium power has been estimated to be at least 25 per cent greater than the cost of an equivalent steam plant. Continued motorship construction, however, indicates that there are enough points of superiority to outweigh this disadvantage. The compactness of the propelling machinery, the small fuel requirements, and the fact that oil can be stored in double bottoms greatly increase the ship's cargo capacity. Low fuel consumption makes a higher rate of speed economically practicable.

In the field of the large passenger liner, long thought to be out of reach of the motorship, steady progress has been made. A 17,000-ton motorship capable of making 17 knots has just been commissioned in the transatlantic passenger service. This record in size and speed will soon be broken, however, as larger and faster vessels are under construction in Great Britain and Italy. A ship is being built in Italy that will register 31,500 gross tons and travel at a speed of 21 knots.

Germany and the Scandinavian countries were among the first to appreciate the possibilities of the internal combustion engine, and have shown the most consistent interest in its application to marine propulsion. Motorships form 13 to 22 per cent of the fleets of Norway, Denmark, and Sweden. Great Britain, with Ireland, owns the largest actual tonnage of motorships, but motorships comprise only 4 per cent of their total registration. Although Britain is also the largest builder of motorships, the motorship has not taken hold there as it has on the Continent. In the United States little interest in motorships has been displayed until recently.

It is not to be assumed that the motorship will drive the steamship out of all services on the seas or that it will even completely eliminate steam in any one service. There will probably always be certain conditions under which it is more profitable to burn coal, and a large number of ships will undoubtedly continue to do so. But if present promises are fulfilled, the motorship will have an increasingly important part to play in the ocean traffic of the world.

* * *

CENTERING BORING MILL WORK

By ANDREW WEBSTER

Referring to the article "Centering Bar for Boring Mill Work" on page 901 of July, 1925, MACHINERY, the writer has employed a somewhat similar method, using wooden, instead of metal cones. The wooden cones were used simply as temporary supports to locate the work in approximately the required position preparatory to the actual setting and clamping. The resilient quality of the wooden cones permits the work to be accurately located and clamped in place ready for the boring operation.

The metal cone method of locating the work described in July MACHINERY would not, of course, meet requirements when the bore must be concentric with the outside surface of the work or when it must be located very accurately with respect to a certain surface or joint.

Time Study in Industrial Management

By J. SETON GRAY, Industrial Engineer, A. O. Smith Corporation, Milwaukee, Wis.

TIME and motion study is the basis on which accurate knowledge of shop operations is founded. Without this knowledge, it is impossible for a foreman, a superintendent, or a factory manager to judge the actual conditions in a factory. A time study shows that many of the old-time methods of performing work are costly and wasteful, and by its use one is able to convince those men who resent changes that, although work has been done in a certain way for years, there are better ways of performing the operations. It shows the easiest way to perform work with the least possible waste. In any factory where a stop-watch has never been used and time studies have not been made, it is inevitable that some resentment will be shown by the organization when such methods are first introduced, and therefore it is important that the principles and object of time study methods be understood.

What is Time Study?

Time study work should be divided under two heads—time study and motion study. By time study is meant the recording of the actual length of time taken to perform the different operations in making the completed article. Observations of every distinct operation are made by the use of a stop-watch, and the length of time taken is carefully noted. By motion study is meant the observation of the various operations or moves made by the operator in performing an operation. It may be found by a careful study that a number of these motions can be eliminated. Often a man must leave his machine after completing one piece, to carry it to the next operation, and then walk some distance in order to get a new piece. Production is interrupted and his machine is idle while he is doing this. If these walks were eliminated, there would be a corresponding increase in production, with no added effort on the part of the man. This is what can be accomplished by motion study.

The object of all time study is to gain accurate knowledge about the work being performed. This knowledge may be used in a number of ways—for determining piece-work rates or the amount of bonus to be paid, for determining the actual plant capacity, and for comparing present methods and equipment with proposed methods and machines. In each instance, carefully made time studies eliminate the guesswork of the past. Too often piece-work rates, for example, have been determined by mere estimates, and the value of new methods or equipment has frequently been appraised in accordance with somebody's opinion, instead of being based on actual facts.

Motion studies can be carried still further, and often this is done, so that every action, no matter how small, is subdivided into its separate motions. As can readily be seen, the more elements into which the study is broken up, the greater is the possibility of finding places where motions can be eliminated.

First Step in Introducing Time Studies

When the management has once decided to make time studies in a factory, perfect frankness should be shown about it. The factory organization should be called together and the reasons presented, and at the same time the man who will have charge of this work should be introduced to the men. It should be made clear to the organization that the adoption of this plan is not to be construed as a criticism of the foremen's work, but that, on account of the scope of their activities, it is desired to assist them in their duties.

They should be told frankly that it is hoped that costs will be reduced by making these studies and production increased, due to the elimination of waste effort. Men will not be required to work harder in order to produce more, but by applying their efforts more intelligently, they will be able to produce more in a given length of time. The company is perfectly willing to pay more for a greater production in the same length of time.

The idea must be accepted by the factory management first of all, before any start can be made in the factory proper. It may take weeks before the organization can be won over to this new way of thinking, and during that time the time study man can become acquainted with the organization as a whole. He can find out where antagonism exists, and gradually overcome it. It should be kept in mind, however, that a general speeding up throughout the factory is not planned, but that a lot of false movements will be eliminated and production increased thereby.

When the factory organization has become reconciled to the presence of the time study man, and he has gradually become acquainted with the different departments, so that he has a general idea of how they function, it is time to make an actual start with time study observations.

General Methods in Time Study Work

A start should be made, if possible, with a department where the foreman has shown himself to be alive to the situation, as the foreman's assistance will be required to obtain the right attitude on the part of the men. If possible, observations should be made on one man rather than on a group of men. A really intelligent man should be chosen as the object of the time study, because it will be easier to explain the fundamental principles of time study work to him.

The time study man should talk to the men personally, tell them exactly what he is going to do, explain the use of the stop watch, and answer any questions that the men may put to him. He should carefully explain to the man under observation that he is to go about his duties in the same way he always has, and not allow the fact that time studies are being made to interfere with his customary routine. After preliminary observations have been made over a period of time, these should be analyzed and shown to the foreman and an expression of opinion obtained from him.

If time studies have not been made in that particular factory before, there will be many places where these studies will show wasted effort on the part of the worker. Let the foreman analyze this condition for himself, after he has been shown what has been found out by the study, and if possible, let him suggest what movements can be eliminated to obtain better results. This will secure the co-operation and good will of the foreman.

When the foreman has once been convinced, the same procedure should be applied to the man, always keeping before him the fact that he is not being called on to increase his effort in any way, but to make all his efforts count. In this way, the best possible result that can be obtained with the facilities at hand can finally be determined, and the foreman and the men, feeling that they are responsible for this result, will be much more friendly toward time study principles than if the scheme had been forced on them without explanation.

Using Time Study for Intelligent Rate Setting

The object of a time or motion study is accurate knowledge, which knowledge may be used in a number of ways, as, for example, paying a bonus for a production over a certain amount, establishing intelligent piecework rates, checking present shop methods against proposed methods. Before any of these things can be done, accurate information must be in the hands of the management, so that standards can be set that will be acceptable to both men and management.

Before time study was instituted, rates were set by the foreman of a department, without accurate knowledge, the result being that if the rates were too high, no sooner did a man demonstrate his ability than the rates were cut. Through accurate time study, once a rate is established, it will remain fixed for a period of time, or until there is a change in the method of doing the work. This accurate knowledge is fair to the men and the management alike, as it lets them both know the possibilities of the job, what the best equipment is, and also what is a reasonable production cost. If it is claimed that the rates are too low, or that it is impossible to achieve the desired number of pieces to earn a fair rate of pay, the time study man should investigate and find out if the claim is based on facts; if the contention of the men is right, he should make whatever adjustment is necessary to establish an equitable standard.

Time and motion study should lead to a better understanding between the men and the management, as guesswork is eliminated. Actual conditions are known and earnings arrived at in an intelligent manner. Workers are paid according to the effort put forth, and if there are men in the factory who are not bearing their fair share of the load, this can soon be determined by the checking-up made possible through time studies.

Many foremen are quite lax in reporting changes in method to the time study man, with the result that the company may spend money furnishing new tools to bring about increased production, and derive no direct benefit from it. Hence the increased earnings all go to the men, and the management, although it may have gone to considerable expense, reaps none of the reward. When there is a change in methods, the time study man should be immediately called in to study the new condition and revise the rates. Time study must be handled so that production is increased without increased muscular strain on the part of the workmen, and so that this increased production will mean increased earnings to both the men and the management.

Time studies, when properly made and used, lead to a better understanding between the management and the employes, because they eliminate guesswork. Actual conditions are known, and any matter at issue can be settled in an intelligent manner by basing the decision on facts. If the factory operates on the piece-work or bonus plan, the workers are paid according to their actual efforts. If there are men in the factory who are not bearing their fair share of the load, this can soon be determined by the evidence presented by time studies. On the other hand, the efficient man reaps his just reward.

What Time is Included in a Time Study?

A time study should show the actual time taken to perform the operation, no allowance being made for extraordinary conditions. The observation, however, should include all extraordinary conditions that may arise, and from this the final time should be determined. There are many conditions that must be allowed for. Take, for example, the changing of cutting tools. In this case, the life of a tool must be determined, and the time for changing spread over the number of pieces that can be run with one set-up. The product may not come to hand in sufficient quantities to allow the men to earn a high bonus. If the job is done on different machines, there may be need for an extra allowance for the difference in the speed of these machines. The actual time taken, plus the amount of time allowed for tool changes, etc., will be the standard time for the job, and this is the basis on which piece or bonus rates must be based. It is not sufficient for a man to earn his day rate on a piece-work job. If you are going to get the maximum effort from him, it must be possible for him to earn from 20 to 40 per cent more than his day rate.

Time Study of Line Operations

In many factories, especially those engaged in the manufacture of automobile parts, there are what are known as line operations. The piece is started by one man, at the head of the line, who performs certain operations; it is then passed on to the next operator for other operations; and so on, until the completed article comes off the end of the line. The idea of line operation is to maintain a steady flow of production and not have material tied up throughout the factory.

Line operations are a fertile field for the time study man, as there is some one operation that controls the production of the whole line. It takes a longer time to perform this operation than any other; consequently if this operation is split up, so that the product will flow by that point faster, the total production of the line will automatically be increased. This can be accomplished by improving the method of doing the operation, or by placing extra help at this point to speed it up. In one factory, where magnetos were assembled, it was found that an extra helper that placed the bodies in position for another worker increased the production of this line 14 per cent.

It must be remembered that when the limiting operation or "bottle neck" is removed from one place, it is created somewhere else, so that the same procedure can be gone through an infinite number of times. The main idea is to increase the total production in a greater proportion than the cost of labor and equipment. In one factory making parts for automobiles, the production was increased over 25 per cent in one year, with the same equipment, by applying these methods.

Time Required for Time Studies

There are many time study men today who can set a rate in a very short time, and be reasonably certain that the rate is accurate. Experience has taught them just what results should be obtained. At the same time, the question often arises, "How long should it take to make a time study?" When starting out, it is best to play safe; studies should be continued until the operations have been checked often enough so that there is no possible chance for error. If, on timing a job twenty times, you get the same result eighteen times, you can be reasonably sure this is representative of the actual conditions.

There is a factory manufacturing parts for automobiles, where the time study department averages, per man, a rate established every forty-five minutes. This is exceptional work, and can only be accomplished by men who know the factory, the product, the organization, and the equipment. It is a good rule, however, especially when starting in for the first time, to be absolutely sure of the standard before it is used for setting piece or bonus rates.

Studies must be fair and impartial, and if there is any doubt, always give the man the benefit of it. Remember what is desired is something that is fair to men and management alike. The management may feel that progress is slow, but changes of this kind cannot take place over night, and if hurried, are likely to cause trouble. Let everybody remember that it has taken years to bring the factory where it now is, and you cannot break the habits formed during a period of years over night. The management must keep in mind that every little bit gained is a step in the right direction, and that as time goes on, these little bits will gradually accumulate until the whole factory is working on this basis. It may take a year, or even five years, to do this, but if the plan is forced on the organization in a hurry, failure will result.

A time study man's work is never done; he should check up on rates that have been in existence for a period of time to see what is being accomplished, and to find whether the work is done in the same way as when the rate was set.

Importance of Maintaining Rates

In many factories, the production is actually limited by the men themselves. From past experience they have found that as soon as their earnings go above a certain point, a cut is made in the piece prices. On account of this, they have determined, over a period of time, just how far they can go and yet have rates remain stable. Time studies will show if conditions of this kind exist—in fact, it will settle all arguments about what is a fair production. The average man fixes in his own mind what his production should be. His associates or men doing similar work, also have in mind what a fair production should be. Then there is the production that the foreman expects of the men. But once the actual production, based on accurate knowledge, has been determined, the production to be expected is fixed beyond argument, and there is satisfaction all around. More especially is this the case when the piece-rate for this standard production is guaranteed for a period of time, so that a man can go just as far as he likes, without danger of criticism from his associates because it will cause a cut in the rates.

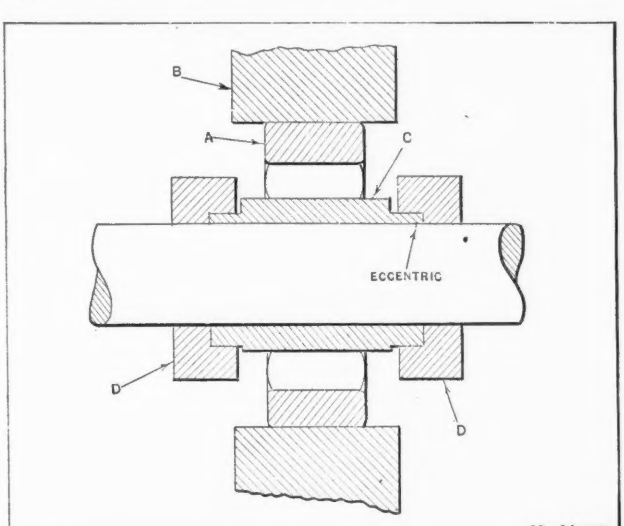
More and more, as time goes on, will the factory manager desire to obtain a measured amount of labor for a given expenditure of money. The employes should learn how these rates are determined, and if the work is not done fairly, should present their arguments to the management. Any factory management that is progressive enough to adopt time study methods, will listen to constructive criticism from its employes. The success of motion and time study work depends on its being acceptable to both employer and employe; and being based on accurate knowledge, it is common sense for both sides to accept it.

* * *

ROLLER BEARING WITH ECCENTRIC LOCKING SLEEVE

By R. H. KASPER

The outer shell *A* of the roller bearing here illustrated is required to remain stationary in the supporting part *B* while the internal sleeve *C* revolves with the shaft. The internal sleeve is longer than the outer shell, and instead of being keyed to the shaft is fastened as follows:



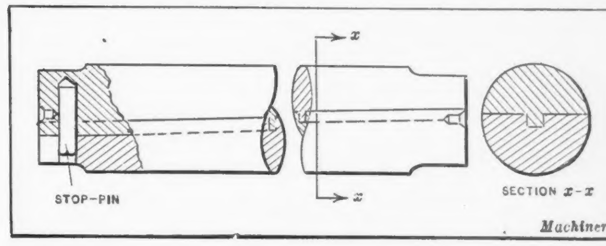
Roller Bearing with Internal Sleeve locked to Shaft

The sleeve is first placed on an arbor, and the projecting ends are ground eccentric with the bore. Two collars *D* are then made, the recesses being machined eccentric with the bore. Next one collar is placed on each end of the sleeve with the eccentrics interlocked. Set-screws hold the collars in place.

BABBITTING MANDREL

By AVERY E. GRANVILLE

A good job in babbitting loose pulleys having solid hubs can be obtained by using a solid mandrel wrapped with paper or heavily coated with lampblack or some similar substance. Many times, however, considerable difficulty is encountered in driving out the mandrel after the babbitt cools. In fact, it is sometimes impossible to drive out the mandrel, and the babbitt has to be melted out and the job done over again, taking more care in coating the mandrel and driving it out before the babbitt has become cold. The babbitt should



Split Babbitting Mandrel

be allowed to cool enough to be hard, but not so much that it will shrink tightly around the mandrel.

It was to avoid the troubles incident to using a solid mandrel that the one shown in the accompanying illustration was designed. This type of mandrel has proved so satisfactory that it is now used for all babbitting work for which it can be adapted.

The mandrel is made from a round bar 1/2 to 3/4 inch larger in diameter than the finished size and long enough to allow about 1 1/2 inches to project from each end of the longest hub to be babbitted. This piece is then split lengthwise diagonally at approximately a five-degree angle, or less, according to the length to be split. The splitting may be done with a milling saw if the mandrel is not too long to permit it to be held properly; otherwise it may be done by hand with a hacksaw. The split surfaces are next smoothed off and splined and feathered so as to fit together nicely. This work is done on a shaper.

After the two pieces are fitted, they are locked together by slipping a lathe dog over them and tightening the setscrew. The dog is put on about the middle of the pieces. The ends of the combination are next centered, care being taken to drill the centers where lines drawn through the major and minor axes of the ends would cross. The mandrel is then placed in a lathe and rough-turned to approximately the desired size. This is done by turning from one end as far as the lathe dog in the middle will allow, then shifting the dog to the turned part and finishing the cut.

A stop-pin is next put in the feather at one end, as shown, and then the mating part is slotted to correspond, so that the pin and end of the slot act as a stop to locate the two parts of the mandrel in the correct relation to each other. The opposite end of the mandrel is flattened so that a clamp can be put on to hold the parts together while pouring the babbitt. The final operation is to put a lathe dog on the mandrel again, and finish-turn to the desired size. This finished size is usually a little larger than the size of the shaft on which the pulley is to run, which does away with scraping for clearance.

This type of mandrel is centered in the pulley hub, and the babbitt poured just the same as if the mandrel were solid. After the babbitt sets, the thin end of the flattened part is driven down through the hub by using a soft piece of iron and a hammer; the whole mandrel then drops out.

* * *

What is known as a "sound-absorbing" plaster which is from eight to ten times as absorbent of sound as ordinary plaster, according to actual tests made by its inventor, has been developed by Dr. Paul E. Sabine of the Riverbank Laboratories near Chicago.

Adapting Standard Equipment to Quantity Production

By M. E. LANGE, Production Engineer, The Warner & Swasey Co., Cleveland, Ohio

ONE of the problems of the manufacturer producing in large quantities is the selection of tooling equipment that can be used for a long period of time in spite of changes in production. If special equipment is used for each job, it becomes obsolete when models are changed or discontinued. When it is possible to develop "universal" tooling equipment suitable for a great variety of work, tooling costs are greatly reduced, over a period of years.

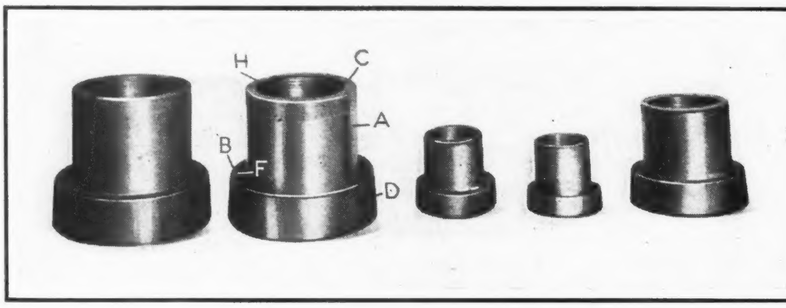


Fig. 1. Different Sizes of Commutator Spiders finished in the Turret Lathe

The turret lathe tooling equipment used in the operation to be described in this article is standard, with the exception of one special attachment. This equipment can therefore be used on a great variety of jobs, besides being flexible enough to handle a number of different sizes of the same piece.

A number of commutator spiders produced in the plant of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., are shown in Fig. 1. In all, thirteen sizes of this part are made by means of the equipment shown in the other illustrations, which was manufactured by The Warner & Swasey Co., Cleveland, Ohio. The flange diameter of the spiders ranges from 4 5/8 to 10 inches, and the length from 4 1/4 to 8 1/2 inches. Some sizes of the work are malleable-iron castings, and others, steel castings with much stock to come off. When the parts come to the turret lathe, the hole is bored to size. The finished limits on the barrel diameter are plus 0.000 and minus 0.001 inch. The large or flanged end of the part is under-cut conically, with surface *F*, Fig. 1, at an angle of 30 degrees, while the periphery of the flange has a taper of 3 degrees. The under-cut must be finished accurately to a gage, concentric with the barrel and with the outside taper.

An expanding arbor of the split bushing type is employed to grip the piece. Three arbors and ten bushings are necessary for the thirteen sizes of spiders. In order to obtain maximum rigidity, the arbor is bushed in the tool-heads mounted on the hexagon turret, and these heads are also piloted overhead. This gives a combination of center and overhead piloting that is equally valuable when roughing and when taking the final finishing cuts on the under-cut portion of the flange. The work is driven by a lug cast on one end, which is substantial enough to permit heavy feeds.

Under-cut *E* is first roughed from the solid by means of a trepanning cutter held on the square turret, and is then rough-formed approximately to size with a bevel cutter that is also mounted on the square turret. Since this forming cut is not accurate enough, a finishing taper cut is taken by means of the special taper boring tool shown at *J* in Figs. 3 and 4.

The tooling equipment on the hexagon turret consists of four multiple turning heads with overhead pilots, and a large Geometric die-head. Three of these multiple turning heads are used for taking turning and chamfering cuts and for finishing the outer edge of the under-cut. The taper attachment of the square turret is used for turning the flange to a 3-degree angle.

The Special Attachment and the Die-head

The special taper boring device *J* for finishing side *F* of the under-cut is mounted on the fourth turning head, as

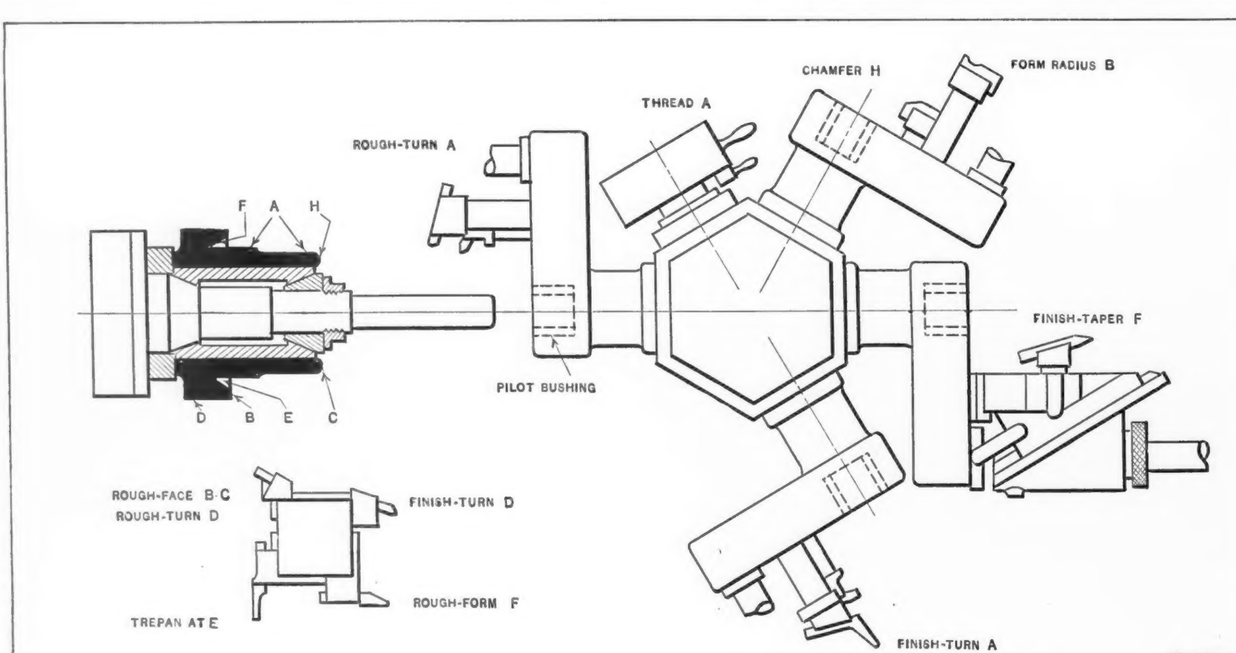


Fig. 2. Lay-out of Tooling Equipment for finishing Thirteen Different Sizes of the Commutator Spiders illustrated in Fig. 1

clearly seen in Fig. 4. Its cost has been substantially reduced by mounting it on a standard head. Another advantage of this method is that the multiple turning head may be used for regular work by simply removing the device. In operation, when the hexagon turret is fed toward the head, the body of the slide pushes against the overhead pilot bracket mounted on the head end of the turret lathe. Then as the turret continues to advance, link mechanism *K* pushes forward the slide that carries tool *L*. This gives the required movement to the tool to finish the taper surface at an exact 30-degree angle. During the entire operation, the arbor of the holding device extends into hole *M* of the multiple turning head to insure rigidity.

The Geometric die-head, which is seen in Fig. 3, cuts threads ranging from 3 3/8 to 7 11/16 inches in diameter. Eight chasers are used for each size of thread. The die-head is mounted on the turret with the usual adapter plate, and a positive feed is used to advance the die-head on the work at the correct lead. A roughing and finishing attachment provide for taking two cuts so as to attain accuracy.

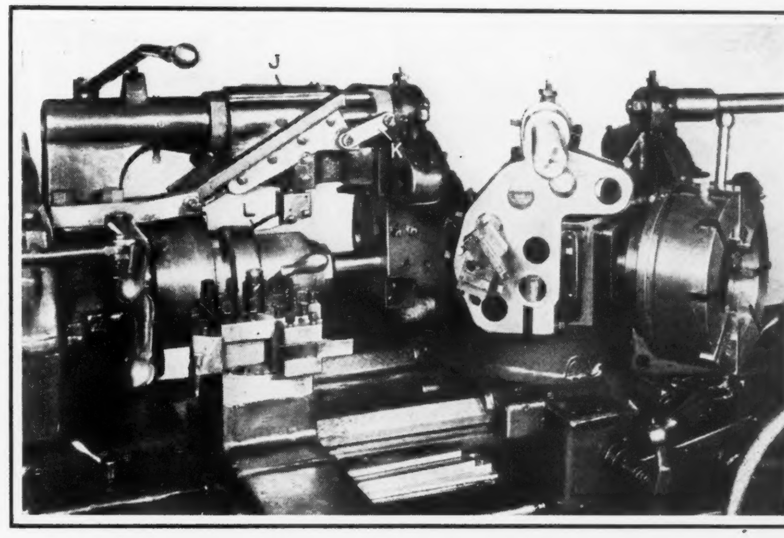


Fig. 3. Close-up View of the Turret Lathe Tooling Equipment, taken from the Front of the Machine

Sequence of the Operation

Referring to the tooling layout shown in Fig. 2, the sequence of the operation is as follows: (1) Rough-face edges *B* and *C* and rough-turn flange *D* to a 3-degree taper with cutters mounted on the square turret and, at the same time, rough-turn barrel *A* with cutters on one of the multiple turning heads of the hexagon turret; (2) rough out under-cut *E* with two cutters mounted on the square turret; (3) finish-turn flange *D* with a cutter on the square turret, and, at the same time, finish-turn barrel *A* with tools mounted on the second multiple turning head of the hexagon turret; (4) finish-bore surface *F* to 30 degrees with the tool of the special attachment mounted on the hexagon turret; (5) round outer edge *B* of the under-cut and chamfer corner *H* with the tools in the fourth multiple turning head of the hexagon turret; (6) rough- and finish-cut the thread of barrel *A* by means of the die-head mounted on the hexagon turret.

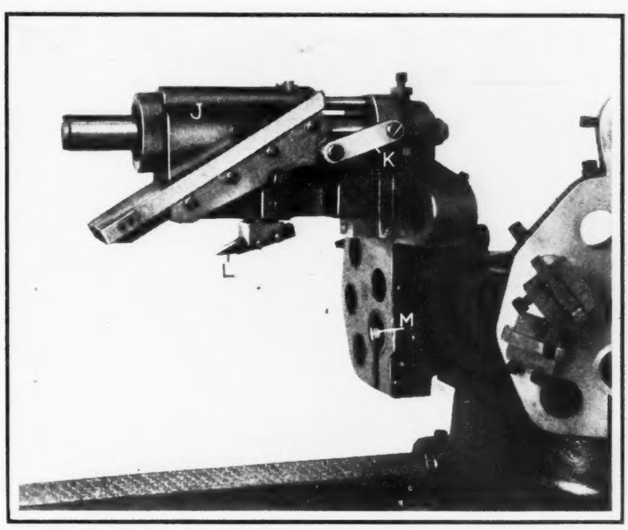


Fig. 4. Special Device designed for finishing the Taper Under-cut Surfaces of the Flange

It was formerly thought impossible to obtain the desired accuracy on this work in a turret lathe. Hence, the engine lathe method was used with a production time of 1 1/2 hours on a certain size of the work. The turret lathe time is 38 1/2 minutes for the same size. This reduction in time is due to the taking of combined and multiple cuts and the use of rigid tooling. Combined cuts are taken by using tools on the square turret simultaneously with the multiple turning heads on the hexagon turret, and multiple cuts are effected by using several tools on the multiple turning heads.

By piloting the tools overhead, as well as at the center, it is possible to use feeds as high as 0.035 inch per revolution of the spindle, with much stock to be removed, maintaining the required accuracy of the piece both for diameter and for concentricity of the various surfaces. The overhead pilot-bars permit heavy feeds by the absorption of torque and the provision of rigidity.

Reducing Tool Costs

This job is interesting as an example of a special tool set-up for quantity production, which is actually made up almost entirely from standard tools. The special features may be withdrawn if the machine is to be used for other purposes. Also, the standard tools used for ordinary production may be used as a base for other standard or special equipment, when the quantity produced warrants it. Generally speaking, standard universal tool equipment equals the performance of special equipment for the majority of work. The exception in the case here described is the special equipment for finishing taper surface *F*, but this unusual problem was met by mounting the special attachment on a standard head. The cost of the tooling equipment was substantially reduced for this job by using practically standard tools, and these tools will be useful for a long time.

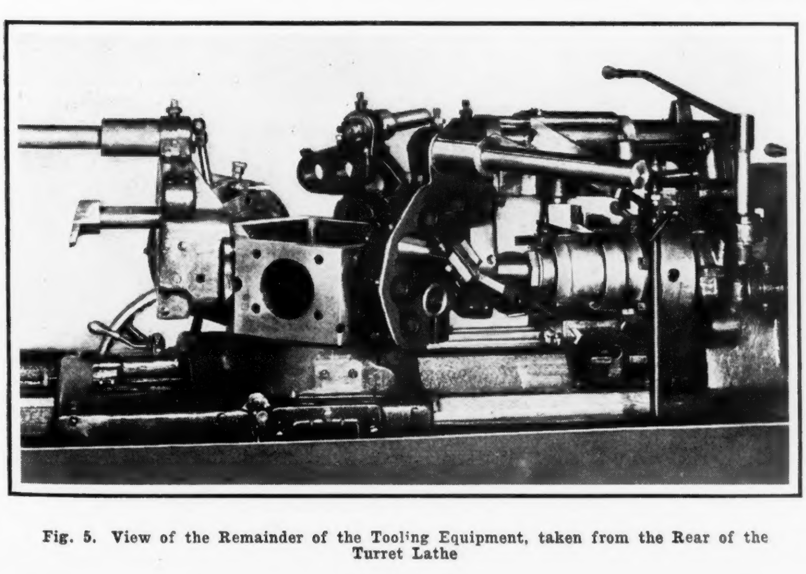


Fig. 5. View of the Remainder of the Tooling Equipment, taken from the Rear of the Turret Lathe

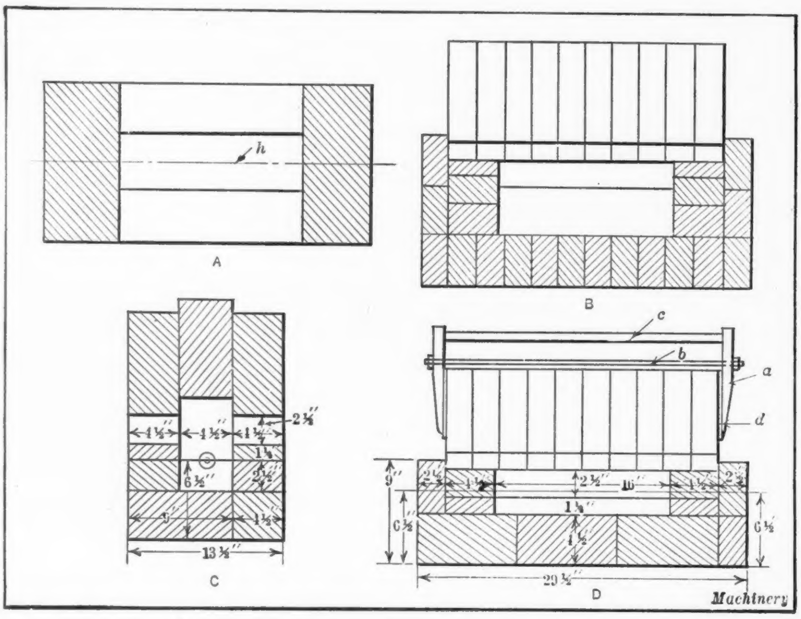
FUEL OIL FURNACE FOR FORGE SHOP

By C. C. HERMANN

The form, size, type, and capacity of the forging furnace should suit the class of work to be handled. Ease of control and flexibility are also important points to consider in designing a forging furnace. Only occasionally is there a shop that has sufficient work of one kind to keep a furnace in continuous operation. More often the furnace is called upon to heat stock of varying sizes and lengths. For this reason some flexibility should be provided for in building every furnace.

Effect of Excess Air

With respect to the furnace control, one of the main points to consider is the elimination of excess air within the combustion space or around the stock being heated. Excess air results in oxidation, which is the burning out of carbon in the surface metal of the stock, thus producing oxide of iron in the form of a black scale. This black scale falls from the heated stock while it is being forged, and not only reduces the size of the stock but fills up the deep recess of the dies and is pounded into the surface of the stock. Thus the scale is often responsible for very rough forgings. Air under pressure must be available for the purpose of blowing the scale from the dies.



Sections of Small Forge Shop Furnace

Effect of Excess Oxygen

When there is an excess of oxygen within the furnace, the flame will be of an oxidizing nature which causes scale to form on the piece of steel being heated, whereas when there is an insufficient amount of oxygen, the flame will be of a reducing nature. In this case, the amount of carbon injected into the furnace in the form of fuels is in excess of that which can be combined with the oxygen to obtain complete combustion, and therefore there is no tendency for the fire to draw upon the carbon in the stock. Under these conditions, however, the furnace will throw out considerable smoke which is objectionable. The black soot will cover the stock and interfere with the forging operation, and the room will be filled with carbon monoxide gas, which is offensive and injurious to the health of the workmen.

The furnace should work at as nearly a neutral condition as possible. Under such conditions, there is just sufficient air present to complete combustion. This condition of operation is difficult to attain, and in practice cannot be fully accomplished. The forging furnace will invariably work in the oxidizing condition in spite of all that can be done. In fact, the only practical method of eliminating oxidation is to employ the muffler type of furnace, wherein the flame is kept entirely away from the stock while it is being heated. The open furnace generally used in forge shop work should throw off transparent products of combustion. If an excess of smoke or dark colored products of combustion are emitted from the furnace, it is an indication of too much oil. The oil supply should then be slightly diminished or the air supply increased.

Construction of Furnaces

The general structure of the furnace varies with the class of work it is to handle. In view *A* of the accompanying illustration is shown a plan sectional view through the combustion chamber of a small furnace. This combustion chamber is 4 1/2 inches wide, 9 inches high, and 21 inches long, and was designed for heating work performed on a bulldozer. The furnace frame consists of 2-inch channel steel legs, which are amply braced and carry furnace supporting members of the same material. The two burners are placed on the center line *h*, view *A*. At *B* is shown a vertical section through the combustion chamber of the same furnace, and at *C* a vertical section at right angles to that shown at *B*.

The floor of the furnace, as indicated in the views *B* and *C*, consist of standard firebrick placed on edge. This construction provides a floor 4 1/2 inches thick. The width of the furnace is made 13 1/2 inches in order to save brick, as this permits the use of 1 1/2-inch bricks in laying the floor. The brick joints are placed in zigzag formation, so a straight continuous joint the length of the furnace is avoided. The front and rear walls are each 4 1/2 inches thick and provide a combustion space of 4 1/2 inches. The cover consists of a triple arch made up of standard firebrick, as shown in view *D*. It consists of a number of bricks held between the cast-iron clamps *a*, which are drawn together by the bolt *b* and a pipe spacer *c*. A steel plate *d* is placed between the clamping plate and the brick to prevent the brick from being broken along the lower edge of the clamp. In making up an arch of this type, the bricks must be placed very close together with just a thin wash of fireclay between the bricks.

The slot to receive the stock is made 2 1/2 inches high and 21 inches long. The combustion chamber is made 3 3/4 inches high, and the center of the burner is located 2 inches above the bottom of the combustion chamber. This brings the center of the burner below the stock so that the high-temperature gases are forced upward and around the stock. The center arch is raised 2 1/2 inches higher than the outside arches in order to provide a cavity above the stock and eliminate any tendency to pocket the high-temperature gases. This also provides a greater refractory area around the stock. For the sake of economy, the over-all length of the furnace should be such that it will accommodate full-size bricks. The bricks usually found best for furnace construction are the standard, split, soap and arch bricks. All these should be of standard stock, as bricks of special size are difficult to obtain when repair work is necessary.

* * *

According to *Railway Locomotive Engineering*, the amount of steam used for blowing locomotive whistles in the United States has been estimated to cost nearly $8,000,000 annually. There are many little things in railroad operation that run into greater items of expense than the average layman would think. For example, the mere starting and stopping of a train at a station is a considerable item of expense, because of the energy lost in applying the brakes and in again accelerating the train to full speed. When a fast, heavy express train has to stop at a station to let off or take on just one passenger, as frequently happens, the mere stopping of the train may more than consume all the profits of carrying the passenger.